

Forest Economics, Management, and Policy in All Flavors:

From Timber Investment and Wood Products to Payment
for Ecosystem Services and Everything in Between

Proceedings of the 2017 Meeting of the
International Society of Forest Resource Economics



Editors: Sun Joseph Chang and Shaun Tanger
New Orleans, Louisiana | May 30 to June 1, 2017

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Organizers:

Louisiana State University Agricultural Center

Preface

The International Society of Forest Resource Economics (ISFRE) began as the Southern Forest Economics Workshop (SOFEW), whose first meeting was in Gulf Shores, Alabama, April 6-7, 1977. Over almost 40 years, then SOFEW, and now ISFRE, has fostered dialogue about research and practice surrounding all aspects of forest economics issues.

At the 2017 ISFRE Meeting, we, the organizers, are particularly interested in those topics with significant financial implications. Researchers and practitioners from New Zealand, Costa Rica, and Oregon, as well as the eastern United States, including Wisconsin, Illinois, Kentucky, Massachusetts, Pennsylvania, Washington D.C., and just about every state in the South, traveled to New Orleans to discuss recent developments related to the management and economics of forest resources. Participants addressed this with 33 oral presentations, 11 posters, one panel discussion and one feature presentation. These presentations addressed several topics, including risk management, payments and incentives, timber and markets, international trade, supply chains, forest management, economic impact analysis, parks and recreation, stated preference, policy and property tax, challenges in Mississippi forestry and non-industrial private forest.

Acknowledgments

We thank Fan Zhang and Joy Das, both graduate students at Louisiana State University, for their on-site assistance with the ISFRE 2017 Meeting. We also thank the ISFRE group at Mississippi State University, led by Robert Grala with assistance from Karen Brasher, for their help with communication to ISFRE members. We particularly want to thank Mary Kelly at the College of Forest Resources, Mississippi State University for her tireless assistance beyond the call of duty after the meeting to get everybody paid on time.

Thanks are due to several judges who judged the student posters. They are Jason Gordon and Steve Grado, of Mississippi State University; Greg Frye, of the U.S. Forest Service; and Puskar Khanal, of Clemson University.

Thanks are also due to the staff at Four Points by Sheraton French Quarter in New Orleans, especially Alisha Staes and Paris Hurst, who contributed in no small way to the success of the meeting.

Finally, we thank all the participants of the meeting, especially the panel discussants — Chris Zinkhan, Andres Katz, and Steve Butler, as well as featured speaker Jingjing Liang, session moderators, oral presenters, and poster presenters.

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Concurrent Session 1A Risk

REAL OPTIONS, TIMBER INSURANCE, AND THE GENERALIZED FAUSTMANN FORMULA

Sun Joseph Chang¹

Abstract —Timber production involves price uncertainty resulting from fluctuations in stumpage prices and volume risk caused by natural and man-made disasters. Past studies of reservation prices have been shown to be the equivalent of a real option. Harvesting decisions based on the reservation price produce results financially superior to that of decisions made under assumption of certainty. Real options, however, are only meaningful if it can be delivered when called upon. When disasters strike, the underlying asset is destroyed and can no longer be delivered, thus making the real option irrelevant. In this paper, I will show that the price uncertainty can be managed with a real option while the volume risks can be addressed through timber insurance. The former will incur the cost of purchasing a put option and the latter would result in an increase in the interest rate. Under such an arrangement, forest management once again becomes decision making under certainty. As such, the generalized Faustmann formula, a priori, determines the optimal planting density and harvest age as well as provides the proper valuation of the timberland.

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DETERMINING THE OPTIMAL LEVEL OF RISK TOLERANCE: A HEURISTIC METHOD TO DEAL WITH PRICE UNCERTAINTY IN FOREST MANAGEMENT

Fan Zhang and Sun Joseph Chang¹

Abstract — While forests grow, the price of timber fluctuates. Most forestland owners usually desire to harvest the trees when the stumpage price is high, provided that the timber volume is large enough. However, such a coincidence does not happen very often, not to mention landowners are hard pressed to judge whether the current stumpage price is high enough. Thus, once the forest becomes merchantable, determining whether to harvest the trees given the current price has been an essential topic for forest management. In this study, the level of risk in terms of stumpage price variation is quantified by using Pressler's index formula. A heuristic Monte Carlo method is established to find the optimal level of risk that landowner should take to maximize the land expectation value. Thereafter, the Southern pine stumpage price in Louisiana from 1956 to 2015 is employed to demonstrate this method. The empirical result shows that an optimal level of risk to take by landowners to maximize the land expectation value can be extracted. In addition, compared to traditional forest management approaches, e.g., Faustmann and reservation price, management decisions made with this heuristic method may lead to better management flexibility and higher land expectation value.

Keywords: Heuristic, Price Uncertainty, Land Expectation Value, Monte Carlo Simulation

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NEW ADVANCES IN MARKOV DECISION PROCESS MODELS FOR FOREST MANAGEMENT; MULTI-CRITERIA AND RISK-SENSITIVE DECISION MAKING

Joseph Buongiorno, Mo Zhou, and Craig Johnston¹

Abstract — This work synthesizes two recent studies extending the classic linear-programming formulations of Markov Decision Process (MDP) models to, respectively, handle multiple objectives and reflect risk preference in forest decision making. One study incorporated goal programming in MDPs with both average and discounted criteria to deal with multiple, often non-commensurable and conflicting, objectives. The other adapted mean-variance or certainty equivalent optimization to MDPs with average rewards to reflect some consequences of the risk attitude of forestry decision makers. Both studies were applied to data for mixed softwood-hardwood forests in the southern United States, with multiple financial and ecological criteria. The results show that given equal weights for normalized criteria, minimum deviations from the highest diversity of tree size and species were achieved at the cost of, on average, one-third of decline of other criteria from their maximum levels. Compared with risk neutrality or risk seeking, financial risk aversion induced shorter cutting cycles, and, besides reducing expected annual financial returns and production, also lowered the expected diversity of tree species and size, stand basal area, stored CO₂e, and old growth area.

Keywords Markov Decision Process, Goal Programming, Risk Preference, Dynamic Programming

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Concurrent Session 1B Ecosystem Services and Values from U.S. Family Forests

ECOSYSTEM SERVICES AND VALUES FROM U.S. FAMILY FORESTS

Jesse Caputo and Brett Butler¹

Abstract — Family forest owners (FFOs), who own more than 35 % of U.S. forestland, are among the most significant suppliers of ecosystem services in the United States. Using results from the USDA Forest Service’s National Woodland Owner Survey (NWOS)—a product of the Forest Inventory and Analysis (FIA) program—we estimate the proportion of FFOs supplying a suite of services to one or more beneficiary groups. We seek to answer two questions: *Who receives the benefits from ecosystem services originating on family forestlands?* and *To what extent do traditional markets capture these services?* Ecosystem services benefit people by satisfying one or more human values. Broadly speaking, values include both use and non-use values; use values include direct and indirect use (from Hansjürgens et al. 2017). Services that satisfy direct-use values include ecosystem goods (provisioning services) and some types of cultural services that require direct interaction with nature. In general, these types of services are classified as excludable services, those for which landowners and managers can control who does and does not receive benefits (i.e., landowners have the legal and technical means to *exclude* potential beneficiaries from enjoying services). We find that 79% of FFOs have supplied one or more excludable ecosystem services to one or more beneficiary groups. These services include wood products, non-timber forest products (including livestock pasturage), and recreation (Figure 1). In most cases, these services primarily benefit FFOs and their family, friends, and close associates and are not bought or sold through traditional markets. An exception is certain types of wood products—specifically logs and wood chips—which are predominantly produced for sale. In contrast to direct use, many ecosystem services satisfy peoples’ indirect or non-use values. These services include regulating and supporting services (e.g., critical ecological functions), biodiversity, and many kinds of cultural services—such as those satisfying existence, bequest, and altruist values. Although most forested lands produce some or all of these services, the extent of this service provision is not easy to quantify. Largely non-excludable (i.e. landowners cannot control who does and does not benefit), these services are also overwhelmingly absent from existing markets. We found that fewer than 1.5 % of FFOs have ever received payments for nature conservation, carbon sequestration, water protection, or wildlife habitat, even though all or nearly all forested properties provide at least some of these benefits. Our work suggests that existing markets fail to adequately capture many of the ecosystem services provided by family forestlands to multiple beneficiary groups, whether this is because benefits flow primarily within close, informal networks (e.g., firewood, NTFPs, or recreation) or whether because benefits are diffuse, non-excludable, and difficult to quantify (e.g., supporting/regulating services, or non-use cultural services)—characteristics that make the creation and use of market instruments difficult or impossible. These findings underscore the substantial challenges implicit in relying on market mechanisms to regulate ecosystem service supply and demand at the landscape, regional, or national levels.

Keywords: Ecosystem services; human values; family forests; markets

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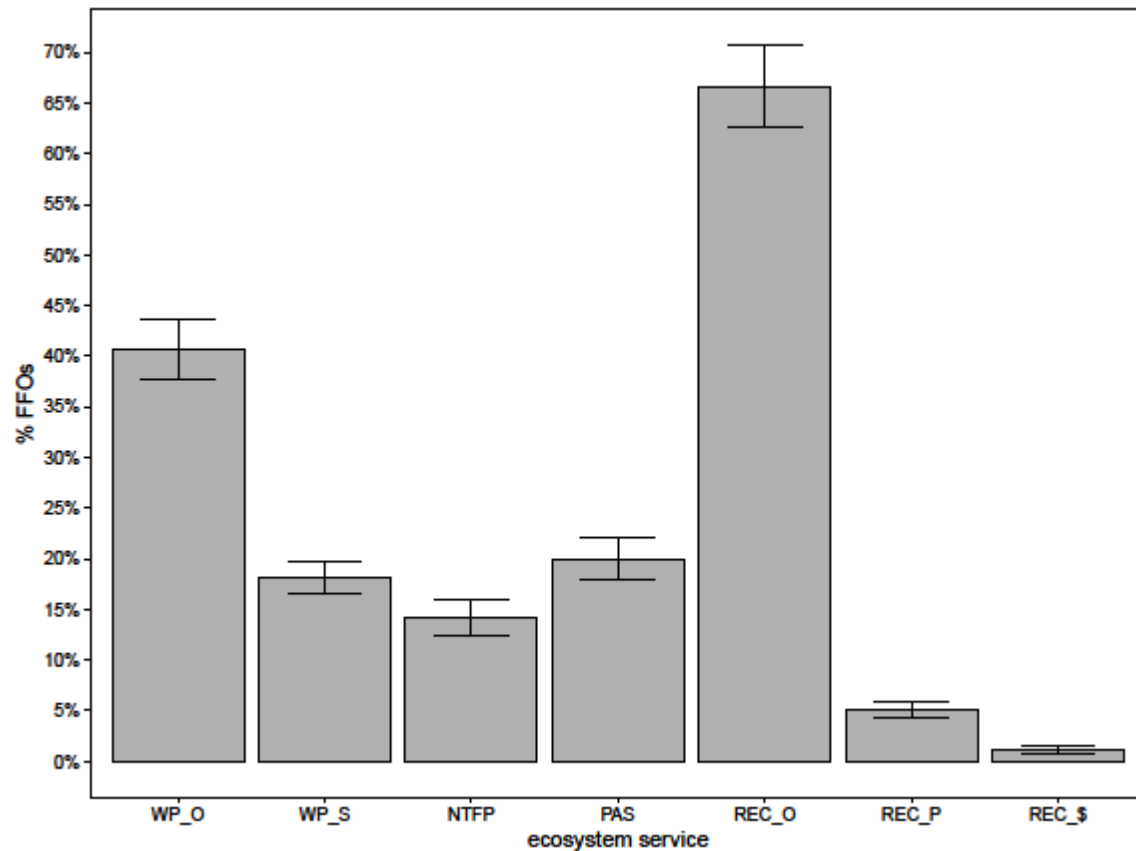


Fig 1. Estimated proportion of family forest ownerships (4+ ha) providing a selection of excludable ecosystem services in the past 5 years, United States, 2011-2013. Error bars represent two standard errors. WP_O = wood products used by owners, WP_S = wood products for sale, NTFP = non-timber forest products, PAS = livestock pasturage, REC_O = recreation by owners, REC_P = free public recreation, REC_ = paid public recreation.

REFERENCES:

Hansjürgens, B, C. Schröter-Schlaack, A. Berghöfer, and N. Lienhoop. 2017. Justifying social values of nature: economic reasoning beyond self-interested preferences. *Ecosystem Services*. 23. 9-17.

RESOURCE ALLOCATION MODEL FOR PUBLIC INCENTIVES FOR FOREST AND LANDSCAPE RESTORATION IN LATIN AMERICA

Rene Zamora-Cristales¹

Abstract—Climate Change represents a major threat to economic and human development, especially in emerging economies around the world. Poverty and inequality have the potential to increase as a result of extreme events such as hurricanes or severe droughts. In Latin America and the Caribbean Region (LAC), a significant amount of greenhouse gas (GHG) emissions are produced from land-use changes from forest to agriculture. Landscape restoration can lead to an increase in rural development by sustainably improving agricultural productivity, habitat quality for wildlife species, water security, soil conditions and other services on degraded lands. A key question that many experts in the area have posed is, how much does landscape restoration cost? Moreover, what is the role of the public sector in promoting restoration activities? Many of the benefits of the restoration process can be catalogued as non-market type (e.g., environmental services, carbon, etc.), although there are benefits such as timber, biomass and the revenues from improving agriculture productivity. In this study we developed a spatially explicit resource allocation model to prioritize the use public incentives for forest and landscape restoration, optimizing different social, environmental, and economic objectives. We developed a case of study in Guatemala where National Forest Law PROBOSQUE incentivizes restoration activities. Results from the model will be helping government officials and landowners to better plan deployment of resources according to different objectives and external factors. The potential benefits of this model include to balance cost of restoration against benefits at the landscape level, maximize the benefits with limited resources and prioritize regions in the landscape in a strategic plan.

Keywords: Economics, Optimization, Land degradation, resource allocation, restoration

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THE EFFECTS OF TARGETING ON EFFICACY AND EQUITY IN COSTA RICA'S PROGRAM OF PAYMENTS FOR ECOSYSTEM SERVICES

Natasha James, Erin Sills, Tabaré Capitán, Francisco Alpizar, Ariana Salas, and Priscilla Rigg¹

Abstract—Like other systems of payments for ecosystem services in developing countries, Costa Rica's PSA (Pagos de Servicios Ambientales) program has dual goals of conserving tropical forest and promoting rural development.

Previous program evaluations concluded that PSA, and more specifically the forest protection modality, fell short of both goals. Quasi-experimental impact evaluations showed that PSA contracts generated little or no additional forest cover. Analysis of participation in the program showed that relatively wealthy landowners with larger properties captured relatively more of the program funds. In its first decade, PSA did not appear to be functioning as a mechanism for either inducing additional forest conservation or for compensating the rural poor for providing ecosystem services that benefit the broader population.

The Costa Rican government responded to these criticisms, first by adding new modalities that make higher payments in areas where forest conservation is expected to generate more valuable ecosystem services, and then by changing acceptance of applications from “first-come, first-serve” to ranking based on priorities. We compiled a database on the distribution of contracts by districts, the characteristics of districts, and changes in program administration in order to estimate how those changes affected both efficacy and equity of participation in the program.

Keywords: Efficacy, Equity, Payment for Ecosystem Services

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Concurrent Session 2A Timber and Markets

AN ECONOMETRIC STUDY OF CHIP-N-SAW STUMPAGE MARKET IN LOUISIANA

Shaun M. Tanger and Rajan Parajuli¹

Abstract—Softwood chip-n-saw (CNS) is a relatively new stumpage product in the sawtimber and pulpwood-dominated stumpage market in the U.S. South. Based on the quarterly data series from 2003 to 2016, this study estimates simultaneous demand and supply models of the softwood chip-n-saw (CNS) stumpage market in Louisiana. The two-stage least squares results reveal that both demand for and supply of CNS stumpage are price inelastic. The harvesting costs and severance tax are found to be significant supply factors, and the lumber price is the main demand determinant of CNS stumpage.

Keywords: Stumpage Markets, Two Stage Least Squares , Chip-N-Saw, Louisiana

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A TWO-SPECIES MODEL OF STUMPAGE MARKETS AND ITS IMPLICATIONS.

Mo Zhou¹

Abstract—In a competitive timber market, price fluctuations are normal as changes in demand or supply, or both, cause adjustments to new equilibria. However, extreme price volatility over an extended period is perilous and calls for particular attention because it creates high risk that could largely undermine the welfare of landowners, forest industries, and consumers. Such price swings impair harvesting and investment decision making, thus endangering the forests and associated ecosystem services. This work attempts to explain volatility and some stylized facts of stumpage prices with a two-species rational expectation equilibrium model. It recognizes that landowners play a part in shaping stumpage prices because stumpage price movements are uncertain, and timber can be stored on the stump without spoiling. Thus, it is presumed that landowners are speculative of future prices and decide how much to store in an effort to gain intertemporal arbitrage profits. In addition, inter-species substitution is considered in the model. An empirical study of Central Hardwood stumpage market is presented at the end.

Keywords: Stumpage price, storage, rational expectation, volatility

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DEVELOPING FOREST PRODUCTS VALUE CHAINS FOR IMPROVING FORESTLAND VALUE OF COMMUNITY-MANAGED TROPICAL FORESTS IN PETÉN, GUATEMALA

Guillermo A. Navarro, Gustavo Pinelo, Rodolfo Vieto, Spencer Ortiz, and Edgar Maraví¹

Abstract—One of the biggest challenges for the sustainability of forest management in the tropics is to find markets and develop forest product value chains that will justify the forest as a competitive land use. In the multiple-use zone of the Maya Biosphere Reserve in Petén Guatemala, forest community concessions struggle to obtain a fair share of mahogany and Spanish cedar value chains. CATIE/Finnfor II, a Finnish Funded Project, has helped forest community concessions in two directions: find better markets for mahogany and Spanish cedar, and find markets for two lesser known abundant species, Pucte (*Bucida buceras*) and Santamaría (*Calophyllum brasiliense*). CATIE/Finnfor II identified several critical points in the value chain of these species: a lack of strategic alliances and market information, low productive yields along the value chain, lack of working capital, and no experience with international commercialization of lesser known species. The project implemented actions in four links in the value chain: 1) sustainable forest management, 2) harvesting and primary transformation, 3) secondary transformation and commercialization, 4) market. CATIE/Finnfor II help with the creation of the Forest Community Fund that helps to finance working capital and investing in new machinery in these four links.

In the case of Mahogany, positive impacts were detected with the establishment of commercial alliances with two musical instrument enterprises of the United States: Two Old Hippies and Taylor Guitars. In 2015, these two enterprises signed purchase contracts for 210 m³ (90 000 bf) in components for making guitars. In addition, these enterprises also offered technical assistance for improving the efficiency and competitiveness of the value chain, and build human capacity. The development of an instrument component value chain allows the communities to capture the value of Mahogany and Spanish cedar. These two species represent more than 95% of the forestland rent considering the availability of volume and excellent price, and from the value chain point of view, 80% of the value is kept in the two first links where the community benefits.

For the lesser known species Pucte (*Bucida buceras*) and Santamaria (*Calophyllum brasiliense*), CATIE/Finnfor II established commercial alliances with Spanish enterprises Arte Latino y Leroy Merlin, which made two purchases of 44,836 m³ (190,104 bt) sawn timber for two products: floors and garden decks in 2014 and 2015. In this case, Forescom, a second transformation enterprise owned by the forest communities, played an important role in the preparation and commercialization of both products. The development of these products help to open an international market for these lesser known species, and increase their price in 210%, and help to make more competitive the forestland as a competitive land use.

Keywords: sustainability, forest products, Petén, value chains, forest management, land expectation value.

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Concurrent Session 2B Trade

A COMPUTABLE GENERAL EQUILIBRIUM ANALYSIS OF THE UNITED STATES-CANADA 2006 SOFTWOOD LUMBER AGREEMENT

Thomas O. Ochuodho, Van A. Lantz, and Edward Olale¹

Abstract - We use a global, dynamic, multiregional, computable general equilibrium model to analyze: (i) comparative economic impacts of the 2006 United States-Canada softwood lumber agreement over the 2007-2013 period; and (ii) extent to which Canadian Provinces made favorable choice of export tax border measure options. Results show that the agreement was effective in curtailing Canada's softwood lumber entry into the United States market. It benefited United States producers through increased stumpage rates while United States consumers lost marginally in welfare due to increased prices while gaining in household income. Canadian producers compensated loss of United States market share by re-directing their exports to rest of the world market. All Canadian provinces except Saskatchewan and Ontario made favorable choices of the export tax border measure options from a consumer welfare perspective. However, alternative export border control measure choices could have had more favorable impacts on other economic variables in these and other provinces.

Keywords: Computable general equilibrium, softwood lumber dispute, export tax, export quota, economic impacts

INTRODUCTION

United States-Canada bilateral trade in softwood lumber is the subject of long-standing and persistent disputes, negotiations, and limited term agreements that have been going on for more than two centuries, dating back to 1789 (Devadoss and others 2005).^[1] The disputes have typically centered around United States claims that fees charged for harvesting softwood on public lands (i.e., stumpage) by certain Canadian provincial governments are artificially low, and that these constitute countervailable subsidies (Gulati and Malhotra 2006).

In the latest round of negotiations, Canada and the United States signed the 2006 Softwood Lumber Agreement, or SLA (USTR 2014). The SLA came into force from October 2006 for an initial seven-year term; in 2013, it was extended for two additional years until October 2015. Following the expiration of the agreement, both United States President Barack Obama and Canadian Prime Minister Justin Trudeau speaking at a joint press conference in March 2016 said the issue came up at their White House meeting but that negotiations were ongoing. President Obama was quoted in *The Globe and Mail* to say "This issue of softwood lumber will get resolved in some fashion . . . It's been a longstanding, bipartisan irritant." Neither side is likely to get everything they are seeking in the final deal.

Under the agreement, Canada imposes a varying export tax on Canadian lumber exported to United States when the price of lumber is at or below US\$355 per thousand board feet (MBF) (US\$ 150.50/m³). This export charge is expressed as a percentage of the price of the product being exported. The lumber price in this case is a weighted average of 15 structural lumber prices as provided for in SLA annex 7A (USTR 2014), commonly known as Framing Lumber Composite (FLC) prices, produced by Random Lengths (2007, 2012). Export charge revenues collected by the government of Canada are distributed to the provinces, minus costs associated with SLA implementation and administration.

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To implement the export charge, there are two border control measure options available for provinces to choose from: (i) Option A — an export charge, with the charge varying with the FLC prices. If a region under this option exceeds its export volume threshold by more than 1 % in any given month, all exports in that month are subject to a retroactive additional export charge, equal to 50 % of that month's export charge rate (the "surge mechanism"); and (ii) Option B — an export charge that is lower than that in Option A and is combined with a volume restraint (i.e., a quota), where both the rate and the volume restraint vary with the prevailing monthly FLC price.^[iii] Table 1 provides details of the two border control measures.

Table 1. 2006 Softwood lumber agreement export border control measures

Prevailing monthly price per thousand board feet	Option A – Export Charge (percent)	Option B – Export Charge Plus Volume Restraint
Over United States \$355	0	0
U.S. \$336-355	5	2.5% + regional share of 34% of U.S. Consumption
U.S. \$316-335	10	3% + regional share of 32% of U.S. Consumption
U.S. \$315 or under	15	5% + regional share of 30% of U.S. Consumption

The *ad valorem* export tax under this trade agreement excludes the Atlantic Provinces of New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland; also excluded are softwood lumber originating from the territories (Yukon, Northwest Territories and Nunavut). Atlantic Provinces are excluded on the grounds that their stumpage pricing systems—the systems through which the provincial governments sell rights to cut standing timber on provincial Crown lands—are “market-determined” and not controlled by the provincial governments. The territories are also excluded as there is no evidence that their stumpage benefits from any government subsidies.

The six provinces subject to the export tax border measures were invited to choose the options that best meet their needs. British Columbia and Alberta initially chose Option A, while Saskatchewan, Manitoba, Ontario, and Quebec chose Option B. Each region can choose to switch options once every three years. Throughout the SLA period, all regions retained their original options.

To date, there has been little economic analysis conducted on the 2006 SLA using global trade models. Specifically, only one study by van Kooten and Johnston (2014) has shed light on the economics of this agreement. Using an integrated log-lumber partial equilibrium global trade model, they considered welfare effects of the removal of the 2006 SLA export restrictions on Canadian lumber exports to United States. They found that Canadian integrated timber harvesting and lumber processing firms gained some \$948.8 million in welfare based on 2010 data, with lumber and log producers in British Columbia receiving the majority of the gains from increased lumber exports to the United States. The United States was estimated to experience a relatively small net loss of approximately \$16 million in welfare as Canadian lumber sales shifted to the United States market. This resulted largely from consumers receiving a gain of more than \$100 million in welfare from lower lumber prices and producers receiving a loss of more than \$150 million in welfare from increased competition by Canadian producers. To some extent, these gains and losses can be simply reversed to get a sense of the economic effects associated with the implementation of the 2006 SLA.

While the van Kooten and Johnston (2014) study sheds some light on economic impacts of the SLA, it failed to link impacts of the SLA with other sectors of the economy through economy-wide impact analysis. Through direct and indirect linkages, changes in one sector of the economy not only affect a particular sector (in this case logging and lumber manufacturing sectors), but many others. Therefore, softwood lumber demand and supply resulting from SLA has direct, indirect, and induced effects on many, if not all, other sectors of the economy as well, such as wood products manufacturing, pulp and paper, housing construction, labor demand, etc. Therefore, analytical tools that will capture such inter-sectoral linkages are required and most appropriate. The computable general equilibrium (CGE) modeling approach is therefore a suitable analytical tool for economic impact analysis of SLA because of its economy-wide and market-based approach (Iglesias and others, 2012). The multi-regional CGE model in particular

is even more appropriate for the analysis as it considers an interactive global economy with interregional trade specified by regions of origin and destination. This allows for the capture of interregional “feedback effects” from global market activities on the region(s) of interest. Both the interregional interactions and feedback effects play a critical role in determining the direction and magnitude of economic impacts in each region from exogenous shocks in their own and other regions (Haddad, 2009; Lofgren and Robinson, 2002; Rickman and Schwer, 1993).

As the SLA closed its first seven years by end of 2013, three critical questions that many industry players and policy analysts would ask are: (1) Did the SLA achieve its objective by reducing Canada’s share of United States softwood lumber market; benefiting United States lumber producers; benefiting Canadian government (households in our analysis) through export tax revenues? If so, to what extent, and how did this vary among the regions? (2) Did the Canadian regions affected by the SLA make the right decisions by their choice of export tax border measures between Option A and Option B? (3) Did the Canadian regions excluded from the SLA gain from, or were harmed by, the agreement, and if so, to what extent and how did this vary among the regions? These research questions lead us to objectives of the study.

The main objective of this study is to assess comparative economic impacts of the first seven years (2007-2013) of the SLA. Specific objective are to: (1) conduct an *ex-post* analysis by retroactively using real export values and export charge rates of Canadian softwood lumber exports to the United States to estimate the comparative economic impacts of the SLA across the regions; (2) determine if the Canadian regions affected by the SLA had made “favorable” export border control measure choices between Option A and Option B (what if the regions that chose Option A had opted for Option B instead and vice versa?). We conducted our analysis over the 2007-2013 period using a recursively dynamic, multi-regional CGE model. The model included 13 regions, including 10 Canadian provinces, the Canadian territories (as one aggregated region), the United States (US), and the rest of the world (RW) region.

To achieve the study objectives, two scenarios are defined:

Scenario1: Implementing export tax charge and quota volumes as per the SLA, following each regions’ initial (current) options: British Columbia and Alberta initially chose Option A while Saskatchewan, Manitoba, Ontario and Quebec chose Option B. This scenario is *ex-post* analysis, which retroactively uses actual data of softwood lumber export values with their corresponding export charge rates (Tables 4 and 5). As part of this scenario, softwood lumber exports from non-participating regions (Atlantic Provinces and the Territories) to the United States are exogenously fixed from their historical actual export data. However, they have a zero-rated export charge.

Scenario2: This is a simple “What-If” analysis where a reversal of *Scenario1* above is implemented with simple assumptions. First, it is assumed that the regions had chosen the alternative export border control measure such that those that had initially chosen Option A (British Columbia, and Alberta) opted for Option B instead while those that had initially chosen Option B (Saskatchewan, Manitoba, Ontario, and Quebec) opted for Option A instead. This scenario further assumes that the original SLA stands throughout the period of study as per SLA, without amendments.

METHODS

The Model

CGE models have been widely used in policy analysis at various levels and scales.^[iii] We specified a dynamic, multiregional CGE model with three input factors (labor, capital, and stumpage) similar to recent one by Ochuodho and Lantz (2014) with a few modifications. The regional economies were aggregated into 23 sectors at small (S-level) aggregation following the Northern American Industry Classification System (NAICS 2002 version).^[iv] In a recursive dynamic CGE model like in this case, economic agents (producers and consumers) are assumed to be myopic about the future and hence assume that current economic conditions will prevail at all periods in the future (Burfisher 2011). Recursive dynamic CGE models are applied by many governmental and international institutions in public policy analysis, such as van der Mensbrugghe (2005), Dixon and Rimmer (2002), Koopman and others (2002), Gottschalk and others (2009). Deverajan and Go (1988) show calibration details of a simple dynamic CGE model of open economy and illustrate its application to examine various policy issues, including terms-of-trade shocks and tariff reform.

Our model is deterministic in nature with assumptions of small-open-economies (price takers) and constant returns to scale technology for each region. The model is formulated as set of simultaneous linear and nonlinear equations, which defined: (i) the behavior of economic agents; (ii) market conditions; (iii) macroeconomic balances; (iv) inter-temporal components; and (v) steady-state economic growth path. Ochuodho and Lantz (2014) provide detailed model description, graphical sketch of commodities flow, and general representation of the CGE model equations. Other studies that have used similar CGE models for policy analysis include Iglesias and others (2012), Zhai and others (2009), and Das and others (2005).

In this study of bilateral trade agreement, specification of foreign trade plays a central role in the modeling framework. Therefore, product imports/exports are differentiated according to their region of origin/destination. On the demand (import) side, domestic consumers discriminate between goods at two levels; first, discriminating between domestically produced and imported goods, and then discriminating between imported goods from different regions. This is known as Armington aggregation through constant elasticity of substitution (CES). Next, we outline key trade and output equations that play a significant role in determining economic impacts of SLA. Throughout this paper, we use subscripts “o” and “d” to designate regions (of origin and destination of imports and exports, respectively, in trade equations), subscript “i” to designate the sector of the economy. Complete listing of model variables, parameters and general representation of equations can be found in Appendix A (Table A2) of Ochuodho and Lantz (2014). The domestic demand of domestic output, XDD_{oi} is given by

$$XDD_{oi} = \left(\frac{1}{\phi A_{oi}} \right)^{\left(1 - \sigma A_{oi} \right)} \left(\gamma A_{oi} \frac{PX_{oi}}{PDD_{oi}} \right)^{\sigma A_{oi}} X_{oi} \quad (1)$$

where X_{oi} is domestic sales of composite commodities; PX_{oi} is the composite export price; PDD_{oi} is the price of domestic sale of domestic output; ϕA_{oi} is the shift parameter in the first-level of Armington function; γA_{oi} is the CES share parameter in first-level of the Armington aggregation function; and σA_{oi} is the Armington substitution between aggregate imports and domestic output.

The aggregate import demand, IMP_{oi} is defined by

$$IMP_{oi} = \left(\frac{1}{\phi A_{oi}} \right)^{\left(1 - \sigma A_{oi} \right)} \left(\left(1 - \gamma A_{oi} \right) \frac{PX_{oi}}{PM_{oi}} \right)^{\sigma A_{oi}} X_{oi} \quad (2)$$

where PX_{oi} is the composite commodities demand price; and PM_{oi} is the domestic price composite imports. The consumer Armington CES cost minimization constraint that govern the two equations above is given by

$$PX_{oi}X_{oi} = PDD_{oi}XDD_{oi} + PM_{oi}IMP_{oi} \quad (3)$$

such that the consumer will buy more from the source (domestic or import market) with lower cost. The CES aggregation function of imports by origins and destinations, MO_{iod} is given by

$$MO_{iod} = \left(\frac{1}{\phi M_{di}} \right)^{\left(1 - \sigma M_{di} \right)} \left(\gamma M_{iod} \frac{PM_{di}}{\left(1 + tmo_{iod} \right) EXR_d PWMO_{iod}} \right)^{\sigma M_{di}} IMP_{di} \quad (4)$$

$$\text{where } \sum_{o=1}^n \gamma M_{iod} = 1$$

where γM_{iod} is the share parameter in the second-level of Armington aggregation function; ϕM_{oi} is the shift parameter in the second-level of Armington aggregation function; σM_{oi} is the substitution parameter of imports from different origins; tmo_{iod} is the import tariff rate; EXR_d is the exchange rate; $PWMO_{iod}$ is the world c.i.f. import price by origin and destination; and PM_{di} is the import price. The cost-minimization constraint of consumer of aggregated imports from various origins is given by

$$PM_{di} IMP_{di} = \sum_{o=1}^n \left(\left(1 + tmo_{iod} \right) EXR_d PWMO_{iod} MO_{iod} \right) \quad (5)$$

On the supply (export) side of the transactions, the export decision of producers is governed by a constant elasticity of transformation (CET) function, which distinguishes between exported and domestic goods such that domestic supply of domestic output, XDD_{oi} is defined by

$$XDD_{oi} = \left(\frac{1}{\phi T_{oi}} \right)^{\left(1 - \sigma T_{oi} \right)} \left(\gamma T_{oi} \frac{PP_{oi}}{PDD_{oi}} \right)^{\sigma T_{oi}} XD_{oi} \quad (6)$$

where XD_{oi} is domestic production (output); PP_{oi} is the composite export price; PDD_{oi} is the price of domestic sale of domestic output; ϕT_{oi} is the shift parameter in transformation function; γT_{oi} is the CET share parameter in transformation function; and σT_{oi} is the CET substitution elasticity between domestic and export markets. The export demand of domestic output, EXP_{oi} is defined by

$$EXP_{oi} = \left(\frac{1}{\phi T_{oi}} \right)^{\left(1 - \sigma T_{oi} \right)} \left(\left(1 - \gamma T_{oi} \right) \frac{PP_{oi}}{PE_{oi}} \right)^{\sigma T_{oi}} XD_{oi} \quad (7)$$

where PE_{oi} is domestic composite export price.

The producer profit maximization constraint that govern the two equations above is given by

$$PP_{oi} XD_{oi} = PE_{oi} EXP_{oi} + PDD_{oi} XDD_{oi} \quad (8)$$

such that the producers will sell more to the destination (domestic or export market) with higher returns. To ensure zero global foreign savings, regional composite export, EXP_{oi} is given by sum of all imports purchased from the region by the importing regions such that,

$$EXP_{oi} = \frac{1}{PE_{oi}} \sum_{d=1}^n \left(\left(\frac{EXR_o}{1 + teo_{iod}} \right) PWE_{O_{iod}} MO_{iod} \right) \quad (9)$$

where teo_{iod} is export tax; and $PWE_{O_{iod}}$ is the world f.o.b. export price.

The region of commodity origin (o) and destination (d) is significant in the pricing system. The export price reflects the price received by the domestic producers for selling their output on the foreign market, while the world export price is the f.o.b. price that already includes export tax such that,

$$PWE_{O_{ido}} = \left(1 + teo_{iod} \right) \left(\frac{1}{EXR_o} \right) PE_{oi} \quad (10)$$

Bilateral trade flows between the 13 regions specified in the model are captured through import by source and export by destination equation specifications.

Production block is governed simultaneously by equations 11-14 below. First, factor demand by firm is given by

$$FAD_{oif} = \left(\frac{1}{\phi V_{oi}} \right)^{(1 - \sigma V_{oi})} \left(\gamma V_{oif} \frac{PVA_{oi}}{PF_{of}} \right)^{\sigma V_{oi}} VAD_{oi} \quad (11)$$

where $\sum_{f=1}^3 \gamma V_{oif} = 1$, f , denotes labor and capital for all sectors and stumpage for forest sector only, where FAD_{oif} is factor demand, VAD_{oi} is composite value-added, PF_{of} is factor price, PVA_{oi} is composite value-added price, ϕV_{oi} is shift parameter in the composite value-added input function, σV_{oi} is elasticity of substitution in the composite value-added function, and γV_{oif} is the share parameter in composite value-added input function.

The composite value-added demand function is given by equation,

$$VAD_{oi} = \left(\frac{1}{\phi P_{oi}} \right)^{(1 - \sigma P_{oi})} \left(\left(1 - \gamma P_{oi} \right) \frac{PD_{oi}}{PVA_{oi}} \right)^{\sigma P_{oi}} XD_{oi} \quad (12)$$

in which, ϕP_{oi} is shift parameter in total cost (production) function, σP_{oi} is elasticity of substitution between the composite value-added input and the composite intermediate input, γP_{oi} is share parameter in total cost (production) function, and XD_{oi} is domestic production (output).

Composite intermediate input demand, IDE_{oi} is given by equation,

$$IDE_{oi} = \left(\frac{1}{\sigma P_{oi}} \right)^{\left(1 - \sigma P_{oi} \right)} \left(\gamma P_{oi} \frac{PVA_{oi}}{PID_{oi}} \right)^{\sigma P_{oi}} XD_{oi} \quad (13)$$

where, PID_{oi} is intermediate input price.

Zero profit condition for the firm is defined by equation,

$$PP_{oi}XD_{oi} = PVA_{oi}VAD_{oi} + PID_{oi}IDE_{oi} \quad (14)$$

such that producers will substitute between value-added and intermediate inputs to reduce costs.

Gross domestic product (GDP) can be estimated either from input side (value-added) at factor prices or from output (final demand) side. At equilibrium, both sides balance. In this study, we estimate GDP from final demand side by summing final demand consumption (C_{oi}) factored by its price (PC_{oi}), investments (I_{oi}), and exports less imports factored by exchange rate (EXR_o) as in equation 15 below

$$GDP_o = \sum_{i=1}^{23} (PC_{oi} C_{oi}) + I_{oi} + \sum_{i=1}^{23} (PE_{oi} E_{oi}) - (PM_{oi} M_{oi}) EXR_o \quad (15)$$

Observed GDP impacts of tariff shocks are therefore attributed to changes in both levels and prices of these GDP components from both final demand and value-added sides.

DATA, MODEL CALIBRATION, AND SCENARIOS

We calibrate the model following procedures and data sources in Ochuodho and Lantz (2014), with a few modifications. Specifically, the model is calibrated to 13 regions comprising 11 Canadian regions (10 provinces and the territories)^[v], the United States, and the rest of the world (RW) using 2006 baseline industry accounts input-output (IO) data, before the softwood lumber agreement came into effect in 2007. In terms of parameter specifications, elasticities of substitution in the composite value-added function and income elasticities of demand for commodities are obtained from Dimaranan and others (2006). Armington CES and CET parameters, along with import tariffs are derived from the GTAP database following sectoral aggregation. For simplicity, and due to lack of region and sector specific (in some cases) empirical data, we assume same elasticities for all regions.^[vi]

To focus our analysis on the lumber market, we needed to isolate the softwood lumber sector in our IO tables. Unfortunately, the North American Industry Classification System (NAICS, 2002 version) does not have softwood lumber as a distinct industry sector under its small (S-level) aggregation for Canadian provinces. However, this sector is contained within the wood products manufacturing sector (NAICS 2002, code 321). Therefore, to disaggregate softwood lumber as a sector from its mother sector of wood products manufacturing in each Canadian province, two steps are followed. First, we establish the 2006 regional ratio of softwood lumber shipments to total wood products shipments using Natural Resources Canada Statistical data on trade (NRCan 2014) and used this ratio to disaggregate total softwood lumber shipments from the total wood products manufacturing sector in our IO table. Second, because there was no other information available, we established the remainder of the IO table transactions using the assumption of the same technology mix for both intermediate and value-added requirements under both sectors. Final demand is similarly estimated assuming same consumer taste and preference between the two sectors.

For the United States softwood lumber sector, we use the ratio of softwood lumber production (output) value data for 2006 (FAO, 2015) to wood products manufacturing to disaggregate the softwood lumber sector from wood products manufacturing in United States IO table in similar way as described for Canadian provinces above. Softwood lumber imports data in United States from Canada were derived from the Canadian (export) side.

For the RW softwood lumber sector, we use the FAO (2015) data in two steps. First we estimated the RW softwood lumber sector output by subtracting sum of Canada and United States production value data for 2006. We then subtract this value from wood products manufacturing sector to disaggregate the two, and followed the same procedure above to fill-out the RW IO table. RW softwood lumber imports from Canada were derived from the Canadian side (international exports excluding US). RW softwood lumber imports from United States were derived from United States side (international exports excluding Canada) (UNCTSD 2014).

For practical purposes of this study, we consider Canadian softwood lumber exports subject to SLA as defined under Annex 1A and further restrict this to only products defined under Annex 7D (10)^[vii] (Canada Treaty Information, 2014). Table 2 provides reference Framing Lumber Composite (FLC) prices upon which Canadian softwood lumber export charge rates are pegged as per SLA. Table 3 shows annual Canadian softwood lumber exports to the United States Table 4 shows annual value of Canadian softwood lumber exports to the United States.

Table 2. Reference monthly framing lumber composite (FLC) prices of softwood lumber

Month	Reference Framing Lumber Composite prices (U.S.\$/MBF) ^a						
	2007	2008	2009	2010	2011	2012	2013
January	278	268	224	251	276	264	357
February	293	262	207	250	291	269	385
March	291	243	195	281	303	283	395
April	289	244	199	311	296	289	416
May	279	238	200	325	288	299	443
June	286	266	207	361	267	321	407
July	292	281	198	316	260	343	356
August	309	263	239	251	264	323	326
September	292	272	235	251	271	328	353
October	288	284	239	247	259	341	353
November	273	255	233	250	265	326	380
December	257	225	238	260	257	334	387
Annual average	286	258	218	280	275	310	380

^aSource: Authors' compilation from Canadian Revenue Agency (2014).

Table 3. Annual volume of Canadian softwood lumber exports to United States

Region of origin ^b	Annual Canadian softwood lumber exports to United States (cubic meters) ^a						
	2007	2008	2009	2010	2011	2012	2013
British Columbia	23,165,673	15,993,383	11,975,872	12,393,421	11,318,978	12,593,177	13,750,915
Alberta	3,277,058	2,902,743	2,424,573	2,444,408	2,145,896	2,248,381	2,618,897
Saskatchewan	169,255	110,125	88,704	102,072	99,124	231,466	205,725
Manitoba	337,813	179,412	31,028	6,440	8,531	24,081	40,584
Ontario	3,550,911	1,944,552	708,089	835,506	1,324,770	1,537,610	1,850,549
Quebec	5,974,998	4,376,440	2,738,547	3,168,637	3,544,423	3,473,503	4,598,458
New Brunswick	1,963,373	1,377,583	1,308,170	1,837,858	1,980,031	1,982,520	2,167,634
Nova Scotia	859,124	513,523	302,902	504,906	430,184	350,403	490,722
Prince Edward Island	29,400	96	0	0	0	0	0
Newfoundland	47,652	24,700	17,316	23,712	28,674	29,872	37,701
Territories	534,000	283,000	212,000	92,000	246,000	71,000	0,000
Canada	39,375,791	27,422,840	19,595,413	21,317,052	20,880,857	22,471,084	25,761,185

^a Softwood lumber products as defined by Annex 1A (1) but restricted to exports products defined by Annex 7D (1a) of 2006 SLA for purposes of volume calculations of United States consumption shares. All volume units converted to cubic meters where necessary by conversion factors in Annex 7D (10).

^b Newfoundland refers to Newfoundland and Labrador as a province; Territories combines Yukon, Northwest Territories and Nunavut. Produced by: BC Stats - Ministry of Technology, Innovation and Citizens' Services.

Source: Statistics Canada, International Trade Statistics.

Table 4. Annual value of Canadian softwood lumber exports to the United States^a

Region of origin ^b	Annual Canadian softwood lumber exports to United States (\$CDN Million)							Total (percent)
	2007	2008	2009	2010	2011	2012	2013	
British Columbia	3,469.312	2,286.106	1,600.501	1,846.092	1,653.327	2,062.459	2,627.431	60.28
Alberta	402.761	314.730	244.054	297.203	250.233	298.733	420.043	8.64
Saskatchewan	23.322	11.026	6.562	6.505	8.562	24.604	29.667	0.43
Manitoba	38.837	18.874	3.192	0.730	1.088	3.157	5.239	0.28
Ontario	446.302	223.258	78.221	103.162	157.961	220.974	306.875	5.96
Quebec	851.883	583.236	353.137	417.905	453.922	521.911	793.932	15.42
New Brunswick	280.984	188.710	176.149	258.185	263.108	290.529	359.670	7.05
Nova Scotia	116.418	66.647	40.907	65.193	54.895	52.494	76.645	1.83
Prince Edward Island	3.740	0.010	0.000	0.000	0.000	0.000	0.000	0.01
Newfoundland	6.011	2.531	1.897	3.151	3.343	3.726	5.717	0.10
Territories	0.096	0.087	0.052	0.020	0.083	0.012	0.000	0.00
Canada	5,640	3,695	2,505	2,998	2,847	3,479	4,625	100.00

^a Softwood lumber products as defined by Annex 1A (1) but restricted to exports products defined by Annex 7D (1a) of 2006 SLA for purposes of volume calculations of United States consumption shares.

^b Newfoundland includes Newfoundland and Labrador as a province; Territories combines Yukon, Northwest Territories and Nunavut. Compiled from: BC Stats - Ministry of Technology, Innovation and Citizens' Services.

Source: Statistics Canada, International Trade Statistics.

Regional annual export charges are estimated by averaging reported monthly rates (Canadian Revenue Agency, 2014). This is straightforward when there are uniform monthly rates, as is the case for all regions under both Options for 2007 and 2008 periods. However, amendments to SLA affected rates for some regions in certain months. Additionally, the “surge mechanism” resulting from trigger volume limit affected the rates in Option A for some regions in certain months. In such cases, regional annual average export charge rates were estimated from the reported monthly rates weighted by their respective monthly export volumes. The export volume is significant here because it is the basis of determining monthly export charge rate in terms of triggering the volume limit in Option A and the export volume quota restriction in Option B. A second reason for the choice of export volume (rather than FLC price) as the weight of annual average export charges is that British Columbia and Alberta, which chose Option A, show greater monthly export charge rate variability as a result of trigger volume limit provision.

Labor supply growth projections for Canadian regions are taken from average annual growth rates (percent) between 2010 and 2014 (Ochudho and Lantz 2014, Statistics Canada 2015). The year 2010 was the earliest start period from the source. For the U.S., we use projected labor supply and productivity average annual rate of change (2006–2016) of civilian labor force from U.S. Bureau of Labor Statistics (USBLS 2014). For the RW, we use annual world (excluding U.S. and Canada) average growth rates from 2004 to 2012 by the World Bank (2014).

Stumpage is exogenously fixed through the time path. Technological progress (total factor productivity) is assumed to be labor-augmented, so the model reaches a steady state in the long run (Zhai and others 2009).

To achieve the study objectives, three scenarios are defined. First, we defined a *baseline* scenario (without softwood lumber tariffs), where we zero-rated softwood lumber export charges from Canada to United States and ran the model over the 2007-2013 period to produce estimates of economic variables without 2006 SLA between the two countries. These estimates are used as reference points to which the other scenarios were compared.

To assess impacts of the 2006 SLA (objective 1), we simulated *Scenario1* using the softwood lumber export values (Table 4) and charges (Table 5) over the 2007-2013 period. Differences in economic outcomes between the *baseline* and *Scenario1* represent the economic impacts of the 2006 SLA.

Table 5. Weighted annual average export charges of softwood lumber exports to United States (percent)

Year	Region of Origin					
	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Quebec
2007	15.0	15.0	5.0	5.0	5.0	5.0
2008	15.0	15.0	5.0	5.0	5.0	5.0
2009	15.0	19.6	5.0	5.0	5.0	5.0
2010	12.4	12.6	6.6	7.9	8.2	7.9
2011	15.0	18.2	7.2	7.8	9.5	12.2
2012	10.9	11.5	3.7	3.9	3.8	6.3
2013	1.5	1.6	0.7	0.7	0.6	2.9

^a Authors' weighted average estimates from monthly rates from Canadian Revenue Agency (2014). British Columbia and Alberta are operating under Option A, while rest of the regions are under Option B. Only regions affected by SLA are presented. Other regions in the CGE model are assumed to have zero rated export charge to all destinations.

To assess whether the provinces selected the 'most favorable' export border control measure choice between Option A and Option B, we simulate *Scenario2*. We do this by simulating the model using the "would be" export values and charges had the provinces selected alternative export border control measure as defined under *Scenario2* and run the model over the 2007-2013 period. Differences in economic outcomes between *baseline* and *Scenario2* represent the economic impacts under *Scenario2*.

The CGE model is solved using the General Algebraic Modeling System (GAMS) software with a nonlinear programming (NLP) algorithm along with CONOPT3 solver (GAMS 2015, Rosenthal 2012).

RESULTS AND DISCUSSION

GDP and Welfare

GDP impacts of the SLA were mixed across Canadian provinces under *Scenario1* where almost half of the regions realized marginal GDP gains and the other half GDP reductions (Table 6). These ranged from a GDP loss of 1.88% in New Brunswick to GDP gain of 1.94% in Saskatchewan, with weighted average gain for Canada of 0.12%. Both United States and the rest of the world realized GDP gains under *Scenario1*. However, under *Scenario2* the Canadian regions' gains/losses were generally intensified relative to those in *Scenario1*, except for British Columbia and New Brunswick, which reverse their GDP losses under *Scenario1* into GDP gains under *Scenario2*. The largest difference in GDP impacts between scenarios emerged in Alberta where it increased from 0.47% under *Scenario1* to 12.27% under *Scenario2*. Alberta contributes the third largest share (17%) of Canada's national GDP (\$1.3 Trillion, 2006 Canadian dollars, reference year) following Quebec (19%) in second place after Ontario (40%), the largest provincial economy. The Canadian overall impacts are weighted averages of the regional impacts. The GDP impacts in major provincial economies above played a major role in increasing Canada's overall GDP gain from only 0.12% under *Scenario1* to 2.45% under *Scenario2*. Under *Scenario1*, United States gains GDP of 1.32%. This increase follows increase in stumpage price (9.9%), rental rate of capital (0.8%), and increase in investments (4%), increase in exports (1.5%). Conversely, United States realizes a loss of 1.17% under *Scenario2*. This is contributed by declines in investments (6%), exports decline (0.4%), marginal declines in both labor and capital expenditures, decreases in final demand prices (5.3%) and export prices (1.8%) coupled with surge in import prices (0.4%). These together lower United States' terms of trade index. The rest of the world realizes GDP gain of 2.21% under *Scenario1*. This GDP gain results majorly from increased investments (5.6%), increase in stumpage prices (10%) coupled with increase in exports (1.4%). Under *Scenario2*, the rest of the world realizes GDP gains at lower rate (1.9%). This impact can be traced to two major sources, a 21% increase in investments and 19% increase in stumpage. These huge increases compensate for reductions in rental rate of capital (3.3%), increase in import prices (7.2%) in the region. Overall, GDP impacts result from factor substitution due to input factor price changes in the composite value-added production function as constrained by final demand impacts in investments, household consumption and net exports.

Welfare impacts were measured using compensating variation, which is the effect of a price change on consumer's overall welfare. It reflects new prices and the old consumer utility level. It is the amount of additional money an agent would need to reach its initial utility after a change in prices (Ochuodho and Lantz, 2014).^[viii] Approximately half of the Canadian Provinces realized welfare losses under *Scenario1*, with the largest loss experienced in New Brunswick at 6.27%. Furthermore, all regions except Saskatchewan and Ontario fair better under *Scenario1* than *Scenario2* in terms of welfare. These results follow same pattern to impacts on consumer price index (CPI) (Table 6). The quota volume restriction under Option B restrains British Columbia's exports to the United States under *Scenario2*. Therefore, the region redirects its "excess" supply to the domestic market thereby dampening the domestic softwood lumber consumer prices. However, both in United States and rest of the world, consumers experience higher prices resulting in welfare losses. This outcome is consistent with theoretical expectations where export quota restrictions are expected to increase supply and lower the price in the domestic market (Canada). On the other hand, these restrictions reduce the supply and increase price in export markets (United States and rest of the world). Welfare impacts in the United States is negligible in *Scenario1* and a loss of 0.2% in *Scenario2*. Rest of the world realizes marginal welfare gain of 0.92% in *Scenario1*. However, the regions suffer 6.62 % welfare loss in *Scenario2*. The regional welfare impacts can be attributed to relative proportional changes in both household income and consumer price index as compensating variation is a welfare measure that uses prices and utility. A classic example is between British Columbia and Ontario welfare impacts under *Scenario2*. While the two regions experienced reduced consumer price indices at 1.34% and 1.15% respectively, Ontario realized welfare gain of 2.75%, while British Columbia recorded welfare loss of 0.07% because Ontario's household income increased by 1.84% against British Columbia's only 0.36% (Table 6).

Table 6. Regional economic impacts of United States-Canada 2007-2013 softwood lumber agreement (percent)

Region ^a	GDP		Welfare (CV) ^b		Household Income		CPI ^c	
	Scenario1	Scenario2	Scenario1	Scenario2	Scenario1	Scenario2	Scenario1	Scenario2
BC	-0.82	0.76	0.69	-0.07	0.25	0.36	0.23	-1.34
AB	0.47	12.27	0.59	0.21	-0.11	0.20	1.04	2.75
SK	1.94	2.59	-0.56	0.24	-0.49	0.49	-0.20	-1.27
MB	-0.19	-1.12	-0.64	-0.88	0.36	-1.04	-1.45	-3.88
ON	0.43	1.61	-0.39	2.75	0.17	1.84	1.97	-1.15
QC	-0.31	-1.94	0.22	-0.62	0.11	-0.49	0.25	-0.05
NB	-1.88	1.00	-6.27	-0.33	-3.56	-0.36	-3.37	-0.68
NS	-1.40	-4.92	-1.26	-7.35	-0.88	-3.44	-0.10	1.49
PE	0.15	0.48	-0.97	-4.08	-0.69	-2.16	0.52	1.68
NL	1.90	1.19	2.30	-0.48	2.79	-0.63	-0.86	0.82
TR	0.36	2.05	1.34	-1.56	1.05	0.44	0.40	3.52
Canada ^d	0.12	2.45	-0.06	0.77	0.06	0.59	0.85	-0.41
US	1.32	-1.17	0.00	-0.20	0.30	0.15	1.19	-1.10
RW	2.21	1.90	0.92	-6.62	1.51	-2.60	-0.60	-4.71

^a BC-British Columbia; AB-Alberta; SK-Saskatchewan; MB-Manitoba; ON-Ontario; QC-Quebec; NB-New Brunswick; NS-Nova Scotia; PE-Prince Edward Island; NL-Newfoundland and Labrador; TR-Yukon, Northwest, Nunavut, and Enclaves, combined; US-United States; and RW-Rest of the World.

^b Compensating variation as a percentage of GDP

^c Consumer price index estimated from a nested Stone-Geary (LES) household utility function

^d Weighted average of Provincial impacts.

Scenario1: First choice of softwood lumber agreement export border control measure

Scenario2: Alternative choice of softwood lumber agreement export border control measure

Welfare impacts were measured using compensating variation, which is the effect of a price change on consumer's overall welfare. It reflects new prices and the old consumer utility level. It is the amount of additional money an agent would need to reach its initial utility after a change in prices (Ochuodho and Lantz, 2014).^[ix] Approximately half of the Canadian Provinces realized welfare losses under *Scenario1*, with the largest loss experienced in New Brunswick at 6.2%. Furthermore, all regions except Saskatchewan and Ontario fair better under *Scenario1* than *Scenario2* in terms of welfare. These results follow same pattern to impacts on consumer price index (CPI) (Table 6). The quota volume restriction under Option B restrains British Columbia's exports to United States under *Scenario2*. Therefore, the region redirects its "excess" supply to the domestic market thereby dampening the domestic softwood lumber consumer prices. However, both in United States and rest of the world, consumers experience higher prices resulting in welfare losses. This outcome is consistent with theoretical expectations where export quota restrictions are expected to increase supply and lower the price in the domestic market (Canada). On the other hand, these restrictions reduce the supply and increase price in export markets (United States and rest of the world). Welfare impacts in United States is negligible in *Scenario1* and a loss of 0.2% in *Scenario2*. Rest of the world realizes marginal welfare gain of 0.92% in *Scenario1*. However, the regions suffer 6.62% welfare loss in *Scenario2*. The regional welfare impacts can be attributed to relative proportional changes in both household income and consumer price index as compensating variation is a welfare measure that uses prices and utility. A classic example is between British Columbia and Ontario welfare impacts under *Scenario2*. While the two regions experienced reduced consumer price indices at 1.34% and 1.15% respectively, Ontario realized welfare gain of 2.75%, while British Columbia recorded welfare loss of 0.07% because Ontario's household income increased by 1.84% against British Columbia's only 0.36% (Table 6).

Bilateral Trade Flows and Terms of Trade

The SLA succeeded in curtailing Canada's softwood lumber exports to United States (Table 7). All Canadian regions experienced export declines under *Scenario1*, ranging from 1.16% in Nova Scotia to 12.13% for New Brunswick except for Ontario and Quebec. The territories' decline of 12.40% is not economically significant as it only constituted negligible (0.0014%) softwood lumber exports to United States. The increases in exports from Ontario and Quebec are significant. Even though both regions were operating under Option B in *Scenario1*, they only constituted a relatively small share of total softwood lumber exports. Therefore, despite quota restrictions, the regions could still afford to increase their export volumes, within the quota ceilings at relatively lower export tariff rates. New Brunswick's exports to United States decline of 2.13% under *Scenario1* is unique given that it is the fourth largest softwood lumber exporter after British Columbia, Quebec and Ontario and is a non-participant in the SLA. It seems that shifts in regional trade patterns and reduced domestic prices enabled New Brunswick to redirect its softwood lumber to domestic markets.

Comparing British Columbia's softwood lumber exports to United States under *Scenario1* vs *Scenario2* explains the whole essence of British Columbia's choice of Option A instead of B. With volume quota restrictions under Option B, British Columbia's exports to United States would have declined significantly by 25% (as shown in *Scenario2*) from only 3.67% (as shown in *Scenario1*). This means that even though the region's softwood lumber prices to United States increased following export tariff charge, it could still afford to export unrestricted volumes of softwood lumber to United States under Option A (*Scenario1*).

The 10.06% increase in Alberta's exports to United States under *Scenario2* could be due to its relatively low export volumes to United States at 8 % of total (less than Quebec's 15%). This means Alberta could still afford to export its maximum potential softwood lumber volume to United States at lower export charge without hitting the quota ceiling. This result raises question on Alberta's initial choice of Option A where it paid a higher export charge with unlimited export volume instead of exporting "equivalent" volumes under Option B but at much lower export charge rates.

Of interest also are the increases under *Scenario2* of exports to United States of four regions of Saskatchewan, Manitoba, Ontario, and Quebec if they went for Option A instead of their original choice of Option B. This implies that these regions benefited from the prevailing lumber prices (Table 2) upon which the export charge rate was pegged.

The relatively large percentage impacts of softwood lumber exports to United States from other Atlantic regions (except New Brunswick) and the territories were relatively insignificant as they constituted only 1.9% of total exports to United States.

Overall, Canada's softwood lumber exports to United States would have been impacted to a lesser degree under *Scenario1* (at a 2.87% reduction) compared to that under *Scenario2* (at a 16.87% loss). Canada compensated for its decline in United States exports under *Scenario2* by re-directing this excess demand to both domestic and rest of the world markets such that overall, Canada's 16.87% decline in United States exports (decrease of 24.57% share in United States consumption) results into an increase of 32.80% of its exports to the rest of the world. However, *Scenario1* has negative impacts on Canada both domestically and abroad in the United States and rest of the world.

The terms of trade index measure the health of the economy. It is estimated by measuring the cash flow into the economy from the export receipts relative to the import expenditures over particular time period. An economy would be doing well (capital accumulation) if export receipts are in excess of import expenditures and vice versa. It is a factor of changes in both export/import quantities and their respective prices. All the Canadian regions except Nova Scotia experienced positive terms of trade under *Scenario1*. This means that overall, Canada is a net exporter (positive foreign savings). Similarly, the United States realized positive capital accumulation under *Scenario1*. Under *Scenario2* Canada experienced overall improved increase of its terms of trade index of 1.07%, up from 0.55% under *Scenario1*. This is due to its huge increase in softwood lumber exports to the rest of world at 32.80%, which compensated for decline of 16.87% of its exports to United States. The terms of trade index impacts for Canada and the United States follow that of their GDP impacts.

Household Income and Consumer Price Index

Weighted average household income for Canada increased from 0.06 to 0.59% from *Scenario1* to *Scenario2* with a mix of impacts at regional level. This change can be attributed to the largest change of stumpage in British Columbia (Table 8), which accounted for 72% of total softwood lumber exports. United States experienced modest household income decline from 0.30 to 0.15% in *Scenario1* and *Scenario2* respectively. This is explained by similar pattern of changes in stumpage. However, for the rest of the world, the case is different. While there is a change of income from a 1.51% gain under *Scenario1* to a decline of 2.60% in *Scenario2* despite the reverse effects on stumpage, differences in the changes in labor expenditures between the two scenarios as indirectly implied by unemployment rate impacts explain the differences (refer to the next subsection).

Table 7. Regional trade impacts of United States-Canada 2007-2013 softwood lumber agreement (percent)

Region ^a	SWL ^b Exports to US		Domestic SWL Sold in Domestic Market		SWL Export Share in US Consumption		SWL Exports to Rest of the World		Terms of Trade Index ^c	
	Scenario1	Scenario2	Scenario1	Scenario2	Scenario1	Scenario2	Scenario1	Scenario2	Scenario1	Scenario2
BC	-3.67	-25.00	-0.20	4.06	-10.83	-40.49	-0.89	31.04	0.42	0.73
AB	-1.84	10.06	-0.79	35.28	-1.23	2.49	0.18	91.82	0.57	2.25
SK	-5.47	5.74	9.04	10.05	-0.50	0.22	1.72	15.89	0.62	1.37
MB	-4.39	1.17	-2.30	3.38	-1.10	-0.12	2.78	11.00	0.21	1.28
ON	2.38	0.43	-0.42	0.32	-1.12	-2.53	11.23	10.04	0.77	1.81
QC	1.79	2.78	0.63	-0.67	-4.39	2.98	-3.68	13.14	0.27	-0.96
NB	-12.13	-43.92	0.51	1.50	-3.34	-9.63	-1.48	23.42	0.90	1.18
NS	-1.16	-1.14	-0.05	3.64	-0.62	-0.29	11.12	122.06	-0.64	-1.66
PE	-8.58	-41.35	0.05	-2.58	-0.09	-0.33	2.57	29.29	0.26	1.10
NL	-7.50	-22.90	-0.33	1.76	-0.05	-0.10	3.24	67.54	1.17	-0.12
TR	-12.40	-40.54	-4.14	-4.20	0.00	-0.01	-1.78	31.32	0.46	3.33
<i>Canada^d</i>	<i>-2.87</i>	<i>-16.87</i>	<i>-0.12</i>	<i>5.60</i>	<i>-7.63</i>	<i>-24.57</i>	<i>-0.84</i>	<i>32.80</i>	<i>0.55</i>	<i>1.07</i>
US	-	-	2.25	1.35	-	-	-1.02	2.05	1.36	-1.54
RW	4.15	-11.28	5.62	3.51	3.24	-32.35	-	-	-1.68	4.40

^a BC-British Columbia; AB-Alberta; SK-Saskatchewan; MB-Manitoba; ON-Ontario; QC-Quebec; NB-New Brunswick; NS-Nova Scotia; PE-Prince Edward Island; NL-Newfoundland and Labrador; TR-Yukon, Northwest, Nunavut, and Enclaves, combined; US-United States.; and RW-Rest of the World.

^b Softwood lumber

^c Laspeyres terms of trade index

^d Weighted average of Provincial impacts.

Scenario1: First choice of softwood lumber agreement export border control measure

Scenario2: Alternative choice of softwood lumber agreement export border control measure

Table 8. Regional capital, stumpage and employment impacts of United States-Canada 2007-2013 softwood lumber agreement (percent)¹

Region ^a	Capital Rental Rate		Stumpage Rate		Unemployment Rate	
	Scenario1	Scenario2	Scenario1	Scenario2	Scenario1	Scenario2
BC	0.19	0.52	19.35	26.27	-0.55	1.06
AB	-0.16	0.26	0.01	-0.01	0.97	0.04
SK	-1.00	1.05	0.00	0.00	0.19	-0.06
MB	0.95	-2.94	0.00	0.00	-0.08	-0.22
ON	1.93	2.02	0.00	0.00	8.96	-18.46
QC	0.04	-1.20	0.00	0.00	-0.47	2.71
NB	-4.71	-0.51	-0.03	0.01	28.82	2.93
NS	-0.92	-3.25	-25.43	0.00	8.76	35.93
PE	-1.23	-1.06	-0.03	0.00	4.31	21.48
NL	3.56	-0.63	-0.02	0.00	-9.96	3.84
TR	1.98	2.53	0.04	-0.04	-5.33	25.88
Canada ^d	0.73	0.50	15.08	20.57	4.26	-5.77
US	0.75	0.40	9.93	7.44	-0.02	0.00
RW	3.71	-3.30	46.68	19.98	0.13	32.74

¹ All prices are seven-year (2006-2013) average in domestic currency

^a Yukon, Northwest, Nunavut, and Enclaves, combined;

^b Weighted average of Provincial impacts.

Scenario1: First choice of softwood lumber agreement export border control measure

Scenario2: Alternative choice of softwood lumber agreement export border control measure

Household Income and Consumer Price Index

Weighted average household income for Canada increased from 0.06 to 0.59% from *Scenario1* to *Scenario2* with a mix of impacts at regional level. This change can be attributed to the largest change of stumpage in British Columbia (Table 8), which accounted for 72% of total softwood lumber exports. The United States experienced modest household income decline from 0.30 to 0.15% in *Scenario1* and *Scenario2*, respectively. This is explained by a similar pattern of changes in stumpage. However, for the rest of the world, the case is different. While there is a change of income from a 1.51% gain under *Scenario1* to a decline of 2.60% in *Scenario2* despite the reverse effects on stumpage, differences in the changes in labor expenditures between the two scenarios as indirectly implied by unemployment rate impacts explain the differences (refer to the next subsection).

The consumer price index (CPI) in United States under *Scenario1* marginally increased by 1.19% (Table 6). In response, the producers in the United States increased their domestic softwood lumber sales and reduced their exports to the rest of the world. However, under *Scenario2*, CPI deflated in Canada as the reductions in softwood lumber exports to the United States were re-directed to the domestic market, thereby ballooning domestic supply and deflating prices. Similar arguments can explain the decline in CPI in rest of the world as Canada “flooded” rest of the world market with excess supply that would have been exported to United States

Capital Price, Stumpage and Employment

The regions realized mixed impacts on rental rates of capital ranging from a gain of 0.04% in Quebec to a loss of 4.71% in New Brunswick. Overall, rental rate of capital for Canada increased by 0.73% and 0.50% in *Scenario1* and *Scenario2*, respectively. These impacts were majorly contributed to by impacts realized in Ontario, which accounted for 35% of Canada’s capital investments. British Columbia, which accounted for 78% of stumpage expenditures and 72% of total softwood lumber exports, realized a 26.27% increase in stumpage rate under *Scenario2*. This can be explained from the increased demand of softwood lumber from British Columbia by the rest of the world. British Columbia shifts its exports from United States to rest of the world. All the other Canadian regions had negligible impacts except for Nova Scotia with a decrease of 25.43%. However, the region only accounted for 0.3% of stumpage payments and therefore had negligible national impact. The impacts had similar general trends under *Scenario2*.

Regarding the unemployment rate under *Scenario1*, it increased by 4.26% for Canada overall. Despite the unemployment rate decline in British Columbia and other Canadian regions, the overall impact to Canada is majorly influenced by the 8.96% increase in Ontario, which accounted for 41% of Canada’s total labor expenditures. Despite

British Columbia's major role in softwood lumber market, it only had 12% of total labor expenditures. This trailed Quebec's 19% and Alberta's 14%. The largest unemployment rate increase of 28.82% in New Brunswick weighed less on the national average as it only accounted for 1.9% of total labor expenditures. Under *Scenario1*, United States marginally benefited with a decline of 0.02% in unemployment rate. However, under *Scenario2*, Canada benefited with a reduction of 5.77% of its unemployment rate. This can be tracked to Ontario's huge reduction of unemployment rate of 18.46%, as it benefits from quota-free export regime by switching to Option A. Other huge increases in unemployment rate in the Atlantic Provinces do not affect Canada's overall impact much as they accounted for only 5.9% of Canada's labor expenditures.

SUMMARY AND CONCLUSIONS

This study has uncovered a number of important findings. First, it confirmed the intuition that the 2007-2013 SLA was effective in curtailing Canada's softwood lumber entry into United States market. The agreement benefited United States softwood lumber producers through increased stumpage rates while United States consumers lost marginally in welfare due to increased price index while gaining in household income. The Canadian government gained through additional export tax revenue. Canadian producers compensated their loss of market share in United States by re-directing their exports to the rest of the world market. These findings are consistent with those of Devadoss and others (2005) and Baek and Yin (2006) on past SLAs, and van Kooten and Johnston (2014) for the 2006 SLA.

Secondly, from a welfare perspective, the study has shown that most provinces (except Saskatchewan and Ontario) made the right choice of export tax border control measure options. However, Canada as a whole would have benefited more in terms of welfare if the provinces had selected the alternative border control measure options (*Scenario2*). Additionally, many provinces would have had preferable GDP and household income impacts if the alternative border control measure options had been selected. Overall Canada would have been better-off under *Scenario2* in terms of GDP, household income, welfare, employment, and terms of trade.

It seems that some regions (Manitoba, Ontario, and Quebec) participating in Option B avoided the quota volume restraint by shifting their exports towards wood manufacturing products that were exempted from quota volume restraint calculations as per annex 7D of SLA. This allowed them to export unlimited quantities of these products, which were only subjected to a 5% export charge.^[x]

Finally, the study has shown the "unintended consequences" of bilateral agreement in other markets. Even though the Atlantic provinces were excluded from the export control measures, they have nevertheless been affected (mostly negatively) by the trade shifts resulting from the SLA. Despite their stumpage being considered "competitive", the Atlantic provinces are not immune to the softwood lumber market influences of the western provinces' big players.

There are a number of weaknesses worth noting in this study. First, it was assumed that all softwood lumber originating from both Ontario and Quebec provinces were subject to the SLA export duty charge. However, annex 10 of the SLA lists some 32 companies from the two provinces (3 Ontario companies and 29 Quebec companies) that were exempted from the export charge.^[xi] The SLA provided for "third-country adjustment mechanism" so as to preserve Canada's share of United States market and to address increases in third-country share of United States market. The study did not take into account this provision, therefore could have overestimated the export charges in such cases.^[xii] Additionally, our study did not take into account the costs associated with the SLA implementation (that are to be subtracted from the Federal Government's transfer of funds to the provinces), which may also lead to an over-estimation of the impacts. Furthermore, due to data limitations, we made a simplifying assumption that the Input-Output structure of the softwood lumber sector mirrored that of the wood products sector as a whole. Future refinements of this and other issues identified above is needed in order to have increased confidence in the estimates.

As a final note of caution in the interpretation of the findings in this study, it should be emphasized that the estimated impacts from CGE models are very sensitive to key elasticities, functional forms, model parameters, assumptions, closure rules, and other factors that embody the models (Arndt and others, 2012; Partridge and Rickman, 1998; Decaluwe and Martens, 1988). These model aspects vary across models given little consensus on any "standards" that apply across the board. The use of same elasticities across the regions (of significantly varying

economic sizes) could explain some relatively high impacts in this study. Despite the caveats, this study has provided framework upon which future studies on this historical bilateral trade dispute can rely upon.

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LITERATURE CITED

- Alavalapati, J., Adamowicz, W., White, W. 1998. A comparison of economic impact assessment methods: the case of forestry developments in Alberta. *Can. J. For. Res.* 28(5): 711–719.
- Arndt, C., Farmer, W., Strzepek, K., Thurlow, J. 2012. Climate change, agriculture and food security in Tanzania. *Rev. Devel. Econ.* 16(3):378-393.
- Baek, J., and R. Yin. 2006. U.S.-Canada Softwood Lumber Trade: Measuring the Market and Welfare Impacts of Restrictions. *For. Sci.* 52(4):390–400.
- Burfisher, M. E. 2011. *Introduction to computable general equilibrium models*. Cambridge University Press, New York, USA. 368 p.
- Canadian Revenue Agency. 2014. Export charge rates. Available online at <http://www.cra-arc.gc.ca/tx/bsnss/tpcs/swl/ptns14-eng.html>; last accessed Apr. 9, 2014.
- Devadoss, S., A. H., Aguiar, S. R., Shook, and J. Araji. 2005. A Spatial Equilibrium Analysis of U.S.–Canadian Disputes on the World Softwood Lumber Market. *Can. J. Agr. Econ.* 53:177–192.
- Das, G. G., J.R.R., Alavalapati, D.R., Carter and M. E. Tsigas. 2005. Regional impacts of environmental regulations and technical change in United States forestry sector: A multiregional CGE analysis. *For. Policy Econ.* 7:25-38.
- Decaluwe, B., and A. Martens. 1988. CGE Modeling and Developing Economies. A Concise Empirical Survey of 73 Applications to 26 Countries. *J. Policy Model.* 10(4): 529-668.
- Dimaranan, B.V., R.A., McDougall, and T.W. Hertel. 2006. Behavioral parameters. In: *Global trade, assistance, and production: the GTAP 6 data base*. Chapter 20. Edited by B.V. Dimaranan. Center for Global Trade Analysis, Purdue University, West Lafayette, Indiana.
- Devarajan, S. and D.S. Go. 1998. The simplest dynamic general equilibrium model of an open economy. *J. Policy Model.* 20(6):677-714.
- Dixon, P.B. and M. Rimmer. 2002. *Dynamic, General Equilibrium Modelling for Forecasting and Policy: A Practical Guide and Documentation of MONASH*. Amsterdam: North Holland.
- FAO. 2015. FAOSTAT. Food and Agriculture Organization of the United Nations Statistics Division. Available online at <http://faostat3.fao.org/download/F/FO/E>; last accessed Feb. 24, 2015.
- GAMS. 2015. *General Algebraic Modeling System*. GAMS Development Corporation. Washington, DC, USA.
- Gottschalk, J., V.M., Le, H., Lofgren, and K. Nouve. 2009. Analyzing Fiscal Space Using MAMs: An application to Burkina Faso. IMF Working Paper WP/09/277. International Monetary Fund, Washington DC, USA.
- Gulati, S., and N. Malhotra. 2006. Estimating export response in Canadian Provinces to the U.S.-Canada Softwood Lumber Agreement. *Can. Public Pol.* 32:157–72.
- Haddad, E. 2009. Interregional Computable General Equilibrium Models. P. 119-154 in *Tool Kits in Regional Sciences, Advances in Spatial Science*, Sonis, M. and G.J.D. Hewings (eds.). Springer-Verlag: Berlin Heidelberg.
- Hicks, J.R., 1939. *Value and Capital: An Inquiry into Some Fundamental Principles of Economic Theory*. Clarendon Press, Oxford.
- Hosoe, N., Gasawa, K., Hashimoto, H., 2010. *Textbook of Computable General Equilibrium Modeling: Programming and Simulations*. Palgrave Macmillan.

- Iglesias, A., L., Garrote, S., Quiroga and M. Moneo. 2012. A regional comparison of the effects of climate change on agricultural crops in Europe. *Clim. Chang.* 112:29–46.
- Koopman, R., H., Arce, E.J., Balistreri and A. Fox. 2002. Large Scale CGE Modeling at the U.S. International Trade Commission. GTAP Resource #1051. Center for Global Trade Analysis, Purdue University, West Lafayette, IN.
- Lofgren, H., and Robinson, S. 2002. Spatial-network, general equilibrium model with a stylized application. *Reg. Sci. Urban Econ.* 32: 651–671. doi:10.1016/S0166-0462(01)00099-0.
- NRCan. 2014. Natural Resources Canada. Statistical Data. Available online at <http://canadaforests.nrcan.gc.ca/statsprofile/trade/>; last accessed May 21, 2014.
- Ochuodho, T.O. and V.A. Lantz. 2014. Economic impacts of climate change in the forest sector: A comparison of single-region and multiregional CGE modeling frameworks. *Can. J. For. Res.* 44:449–464.
- Partridge, M. and D. Rickman. 1998. Regional computable general equilibrium modeling: a survey and critical appraisal. *Int. Reg. Sci. Rev.* 21(3): 205–248.
- Random Lengths. 2012. Random Lengths Framing Lumber and Structural Panel Composite Prices, by month. Available online at <http://www.randomlengths.com/in-depth/monthly-composite-prices/> last accessed Jul. 18, 2016.
- Random Lengths. 2014. Information about the current U.S.-Canada trade deal. Available online at <http://www.randomlengths.com/In-Depth/U.S.-Canada-Lumber-Trade-Dispute/>; last accessed Apr. 9, 2014.
- Reed, L. 2001. Two Centuries of the Softwood Lumber War between Canada and the United States: A Chronicle of Trade Barriers Viewed in the Context of Sawtimber Depletion. Report prepared for the Free Trade Lumber Council, Montreal.
- Rhaman, S. and S. Devadoss. 2002. Economics of the United States-Canada softwood lumber dispute: A historical perspective. *The Estey Centre J. Int. L. T. Pol.* 3(1):29-45.
- Rickman, D.S., and Schwer, R.K. 1993. Regional definition in regional economic impact models: the case of the REMI model and Clark County, Nevada. *Econ. Systems Res.* 5(4): 419–432. doi:10.1080/095353193000000033.
- Rosenthal, R.E. 2012. GAMS: A user's guide. GAMS Development Corporation, Washington, DC.
- Shoven, J. B. and J. Whalley. 1992. *Applying General Equilibrium*. Cambridge University Press, Cambridge. 303 p.
- Statistics Canada. 2015. Statistics Canada Table 052-00051. Projected population, by projection scenario, sex and age group as of July 1, Canada, Provinces and territories, annual (persons). Available online at <http://estat.statcan.gc.ca/cgi-win/CNSMCGI.EXE>; last accessed Jan. 11, 2015.
- Statistics Canada. 2014. Statistics Canada Table 381-0013. Inputs and outputs, by industry and commodity, S-level aggregation and North American Industry Classification System (NAICS), Ottawa, ON.
- UNCTSD. 2014. United Nations Commodity Trade Statistics Database. Available online at <http://comtrade.un.org/db/default.aspx>; last accessed Jun. 5, 2014.
- USBLS. 2014. U.S. Bureau of Labor Statistics. Table 1: Summary of results of BLS aggregate economic projections, 1986, 1996, 2006, and projected 2016. Labor supply and productivity. Average annual rate of change (2006–16). Available online at <http://stats.bls.gov/opub/mlr/2007/11/mlr200711.pdf>; last accessed Apr. 9, 2014.
- USTR. 2014. U.S. Trade Representative. Softwood lumber agreement between the government of Canada and the government of the U.S. of America. Available online at https://ustr.gov/archive/assets/World_Regions/Americas/Canada/asset_upload_file667_9897.pdf last accessed Jul. 18, 2016.

Van der Mennsbrugge, D. 2005. LINKAGE Technical Reference Document, Version 6.0. Development Process Group (DECPG). World Bank, Washington, DC.

Van Kooten, G.C. and C. Johnston 2014. Global impacts of Russian log export restrictions and the Canada–U.S. lumber dispute: Modeling trade in logs and lumber. For. Policy Econ. 39:54–66. Varian, H.R., 1999. Intermediate Microeconomics: A Modern Approach, Fifth edition. W.W. Norton & Company, New York.

World Bank. 2014. World DataBank. World Development Indicators. Population growth (annual percent). Available online at <http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators>; last accessed Jul. 18, 2016.

Yin, R. and J. Baek. 2004. The U.S.–Canada softwood lumber trade dispute: What we know and what we have to know. For. Policy Econ. 6:129–143.

Zhai, F., T., Lin, and E. Byambadorj. 2009. A General Equilibrium Analysis of the Impact of Climate Change on Agriculture in the People's Republic of China. Asian Dev. Rev. 26(1): 206–225.

Zhang, D. 2007. The Softwood Lumber War: Politics, Economics, and the Long United States–Canadian Trade Dispute.

Endnotes

ⁱ Reed (2001) provides chronology of the dispute before 1981; Rhaman and Devadoss (2002) provide a detailed discussion of the disputes covering the period 1981–2000; Yin and Baek (2004) outline the history of the dispute and critique past studies of various United States–Canada softwood lumber trade agreements; Random Lengths (2014) provides a succinct summary of monthly events of the dispute in a historical timeline from 1982 to 2012; Zhang (2007) gives a more detailed account of the real players in this dispute and many of its economic and policy consequences from its inception from Lumber I through Lumber IV until the signing of 2006 Softwood Lumber Agreement.

ⁱⁱ Article VII of the SLA details the export charge and export charge plus volume restraint for the two options. Calculations of quota volume and that of United States consumption and market share are in annex 7B and 7D of the SLA respectively while annex 8 details calculations of regional trigger volume under option A. Annexes 1A and 1B details softwood lumber products covered by the SLA (USTR 2014).

ⁱⁱⁱ For extensive review of CGE modeling technique and its applications, see Haddad (2009), Partridge and Rickman (1998), Shoven and Whalley (1992), Decaluwe and Martens (1988), and Hosoe et al. (2010)

^{iv} The NAICS 2002 version has 25 sectors. However, we disaggregated manufacturing [31–33] into three sectors: softwood lumber [from 321], pulp and paper manufacturing [322] and ‘other manufacturing’ [31–33 except 321 and 322]. We also aggregated five other service sectors into one sector: Other services (except public administration) [81]; Operating, office, cafeteria, and laboratory supplies [not NAICS defined]; Travel and entertainment, advertising and promotion [not NAICS defined]; Transportation margins [not NAICS defined]; and Non-profit institutions serving households [8131] (numbers in parenthesis represent NAICS 2002 codes). For further details on the sectors, see Statistics Canada Table 381-0013 (Statistics Canada 2014).

^v These provinces from east to west are: Newfoundland and Labrador (NL); Prince Edward Island (PE); Nova Scotia (NS); New Brunswick (NB); Quebec (QC); Ontario (ON); Manitoba (MB); Saskatchewan (SK); Alberta (AB); British Columbia (BC) and the Territories which includes Yukon, Northwest, Nunavut, and Enclaves (TR).

^{vi} CGE model results are sensitive to key parameters such as elasticities. However, there is little consensus among CGE modelers on the magnitude of these elasticities that would be considered ‘suitable’ under various modeling conditions (Arndt et al., 2012; Partridge and Rickman, 1998). Deriving elasticities from primary data is no menial task due to large data requirements over a long period of time. Modelers have tended to rely on elasticities from the literature and at times assign their own values using authors’ judgment (e.g., Alavalapati et al., 1998).

^{vii} This left out only three categories of actual softwood lumber exported to United States (Canadian Custom Tariff: 44189099, 44219060, and 44219090), which include joinery and carpentry wood, fence rails and sawn pickets; and wood articles (value data are available without quantity units). It is significant to note that these products don’t play role in SLA and are only prominent in regions participating in Option B (particularly, Manitoba, Ontario, and Quebec), where they have been excluded from quota volume calculations as per annex 7D of SLA. Therefore, excluding these products was a matter of necessity rather than choice for practicality of calculation of regional quota volumes for Option B and regional trigger volumes for Option A as per Annex 7B and 8 of SLA, respectively.

^{viii} Compensating variation is estimated using expenditure function using new prices and the old utility level. Equivalent variation (EV) is a closely related measure of welfare that uses old prices and the new utility level. It estimates amount of money agent would pay to avoid a price change, before it happens. In this study, CV was a more appropriate measure of welfare than EV because of ex-post (retroactive) analysis rather

than anticipatory (what would be). Compensating variation represents a more accurate estimate of welfare than consumer surplus because the former accounts for income effects while the latter does not. When the good is neither a normal good nor an inferior good, or when there are no income effects for the good, then EV (Equivalent variation) = CV (Compensating Variation) = CS (Change in Consumer Surplus) (for more details, see Hicks 1939, Varian 1999).

^{ix} Compensating variation is estimated using expenditure function using new prices and the old utility level. Equivalent variation (EV) is a closely related measure of welfare that uses old prices and the new utility level. It estimates amount of money agent would pay to avoid a price change, before it happens. In this study, CV was a more appropriate measure of welfare than EV because of ex-post (retroactive) analysis rather than anticipatory (what would be). Compensating variation represents a more accurate estimate of welfare than consumer surplus because the former accounts for income effects while the latter does not. When the good is neither a normal good nor an inferior good, or when there are no income effects for the good, then EV (Equivalent variation) = CV (Compensating Variation) = CS (Change in Consumer Surplus) (for more details, see Hicks 1939, Varian 1999).

^x In this regard, Manitoba, Ontario, and Quebec increased their export values of the exempted products, which includes builder's joinery and carpentry of wood, fences and fence sections of wood, prefabricated, including fence rails and sawn pickets, and wood articles. It is significant to note that Ontario and Quebec (operating under Option B) peaked the share of the exempted products with the economic downturn witnessed in 2009 which recorded lowest FLC prices (Table 2). Total value of their exempted products accounted for 34% and 39% of total softwood lumber exports to United States for Ontario and Quebec respectively.

^{xi} These companies were previously found by United States authorities not to benefit from alleged subsidies. In this regard, our analysis has somehow overestimated the export charges from these two regions as a result. The extent of which depends on the unknown actual softwood lumber export volumes to United States from the exempted companies over the seven-year study period. The analysis subjected the total provincial softwood lumber exports to United States to the export tax and quota restrictions.

^{xii} The SLA allows the Government of Canada to retroactively refund export charges (up to the equivalent of a 5% charge) if all of the following circumstances occur in two consecutive quarters when compared to the same two consecutive quarters in the preceding year: third-country share of United States market increases by 20%; Canadian market share decreases; and United States domestic producers' market share increases. This was the case in some months for some regions (Alberta for October and November 2008).

SUPPLEMENTAL MATERIALS

Table SM1: Elasticity parameters

Sector (NAICS 2002 Classification)	SigmaV	SigmaA	SigmaT	SigmaP	SigmaM	SigmaY
Crop and animal production	0.23	2.5	-2.5	0.12	4.9	0.21
Forestry and logging	0.12	2.5	-2.5	0.12	5.0	0.85
Fishing, hunting and trapping	0.20	1.3	-1.3	0.12	2.5	0.58
Support activities for agriculture and forestry	0.20	5.7	-5.7	0.12	12.1	1.06
Mining and oil and gas extraction	1.26	2.8	-2.8	0.12	5.6	1.06
Utilities	1.40	1.9	-1.9	0.12	3.8	1.06
Construction	1.26	3.4	-3.4	0.12	6.8	0.85
Softwood lumber manufacturing	1.26	3.0	-3.0	0.12	5.9	0.85
Pulp and paper manufacturing	1.24	3.3	-3.3	0.12	7.1	0.85
Other manufacturing	1.68	1.9	-1.9	0.12	3.8	1.11
Wholesale trade	1.68	1.9	-1.9	0.12	3.8	0.95
Retail trade	1.26	1.9	-1.9	0.12	3.8	0.95
Transportation and warehousing	1.26	1.9	-1.9	0.12	3.8	1.22
Information and cultural industries	1.26	1.9	-1.9	0.12	3.8	1.19
Finance, insurance, real estate and rental and leasing	1.26	1.9	-1.9	0.12	3.8	1.19
Professional, scientific and technical services	1.26	1.9	-1.9	0.12	3.8	1.19
Admin. & support, waste management & remediation services	1.24	1.9	-1.9	0.12	3.8	1.19
Educational services	1.68	1.9	-1.9	0.12	3.8	1.19
Health care and social assistance	1.68	1.9	-1.9	0.12	3.8	1.19
Arts, entertainment and recreation	1.26	1.9	-1.9	0.12	3.8	1.19
Accommodation and food services	1.26	1.9	-1.9	0.12	3.8	1.19
Other goods and services	1.26	1.9	-1.9	0.12	3.8	1.19
Government services	1.26	1.9	-1.9	0.12	3.8	1.19

Parameter Key

SigmaV - Elasticities of substitution in the composite value-added function

SigmaA - Elasticities of substitution in Armington CES function

SigmaT - Elasticities of transformation in CET function between domestic and export markets

SigmaP - Elasticities of substitution between the composite value-added input and the composite intermediate input

SigmaM - Elasticities of substitution of imports of different origin

SigmaY - Income elasticities of demand for commodity

Phillips curve parameter = 0.1

Nested-LES utility function Frisch parameter = 2.1

Sources: Dimaranan et al. (2006); GTAP 7 Data Base, 2004 baseline.

EFFECTS OF INTERNATIONAL TRADE, PROTECTIONISM AND TRADE WARS ON THE GLOBAL FOREST SECTOR

Joseph Buongiorno, Craig Johnston, and Shushuai Zhu¹

Abstract—The importance of international trade for the welfare of actors in the forest sector was estimated by comparing the current state of the world with a world in pure autarky with zero imports and exports. Globally, international trade did have a positive effect on the economic welfare of the sector. But while wood producers in developed countries increased their profits with trade, those in developing countries incurred heavy losses that negated any incentive to invest in forest conservation, management, and new plantations. In case of a trade war with prohibitive US tariffs and retaliatory foreign measures, the profits of U.S. wood producers would decrease by 8%.

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IMPACT OF BREXIT ON THE FOREST PRODUCTS INDUSTRY IN THE UNITED KINGDOM AND THE REST OF THE WORLD

Craig M.T. Johnston and Joseph Buongiorno¹

Abstract—The Global Forest Products Model was applied to forecast the effect of Brexit on the global forest products industry to 2030 under two scenarios: optimistic and pessimistic future storylines regarding the potential economic effect of Brexit. The forecasts integrated a range of gross domestic product growth rates using an average of the optimistic and pessimistic projections from recent reports. According to the results, Brexit caused a sustained modest decline in U.K. demand for wood products through 2030. The consumption of sawnwood in Britain was 1.0% to 2.1% lower by 2030, 2.9% to 6.1% lower for wood-based panels, and 1.9% to 4.1% lower for paper and paperboard. With Brexit, the U.K. net trade deficit in sawnwood decreased by 4.8% to 9.9% by 2030, 4.4% to 9.1% for wood-based panel, and 5.5% to 10.8% for paper and paperboard. The effects on industrial roundwood consumption and production within the U.K. were negligible. Both scenarios had a modest adverse effect on the global market for wood products. The consequences of Brexit were mostly within Europe and driven predominantly by reduced consumption within the U.K. itself. While the effect was greater under the pessimistic scenario, the overall impact on the global wood products industry was small, and it had no discernable effect on prices.

Keywords: Brexit; Forest sector modeling; Trade; Consumption; Production; Wood products

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EFFECTS OF ANTI-DUMPING AND COUNTERVAILING DUTIES ON THE MARKET VALUE OF U.S. PETITION FIRMS IN FORESET PRODUCTS MARKETS

Xufang Zhang and Changyou Sun¹

Abstract—Anti-dumping (AD) and countervailing (CV) duties are used as an alternative mechanism to protect domestic firms from possible injury by unfair international trade in this increasingly competitive international market. China is a particularly useful starting point for a variety of reasons among all the countries who used AD and CV duties. The United States and China are held most responsible for the massive global economic imbalances that are thought to have bred the recent financial crisis. This study estimates AD and CV duties on the case of wooden bedroom furniture and coated free sheet paper in China and extends the existing literature of market power related to the U.S. paper and furniture industry by conducting the comparison on different two forestry industries. This research applied the event study method to analyze the average cumulative abnormal returns of public petition firms in U.S. during AD and CV duties and conducted the risk analysis on individual firms before and after AD and CV duties through capital asset pricing model. The results showed that there would be positive and significant average cumulative abnormal returns before the Department of Commerce (DOC) published a preliminary announcement and negative average cumulative abnormal returns after DOC published the preliminary announcement. Besides, the influence on petition firms were related to the market value and the position of petition firms. However, the magnitude of cumulative average abnormal returns of wooden bedroom furniture case were much larger than the cumulative average abnormal returns on the case of coated free sheet paper. What's more, the risk estimates on the case of coated free sheet paper are larger than the case of wooden bedroom furniture for the position of petition and the cooperation between them and the accused firms in China. The paper analyzed the result and explained the similarities and differences between these two cases. Results and conclusions in this paper will be helpful in understanding the differ behavior in the U.S. paper and furniture industry.

Keywords: Anti-dumping and countervailing; Wooden bedroom furniture; Coated free sheet paper; Event study; Capital Asset Pricing Model.

INTRODUCTION

In this increasingly competitive international trading system, exporters are threatened by frequently changing temporary trade barrier policies, such as AD and CV duties based on their simultaneously low applied import tariffs on average (Wang and Reed, 2015). AD and CV duties are used as an alternative mechanism to protect domestic firms from possible injury by unfair international trade in this framework for the international trading system (Brander and Spencer, 1981; Reynolds, 2006; Gayle and Puttitanun, 2009). The trend of using AD and CV duties as effective remedy actions against imports has become exceedingly popular (Schuler et al., 2002; Feinberg and Reynolds 2008). There are 4230 AD investigations and 302 CV investigations from 1995 to 2012 initiated by more than 40 World Trade Organization (WTO) member countries, according to the report of WTO (Li et al. 2014).

The financial performance of the U.S. forest products industry has been unstable and weak in recent decades, although it has been one of the primary manufacturing sectors in United States (U.S. Census Bureau 2006, Mei and Sun 2008a, U.S. Census Bureau 2016). There exists many AD and CV duties on three subindustries of the U.S. forest products industry: timber, furniture and paper industries (Mei and Sun 2008b, Luo et al. 2015), which are used to protect the values of U.S.-related firms and control inappropriate imports from other “dumping” countries. However, seldom did research combine and compare the AD and CV effect on U.S. firms both in the paper industry and the furniture industry because most research analyzed AD and CV duties based on separate forest products industries (Pesendorfer 2003, Li et al. 2004, Sun 2006, Mei and Sun 2008a, b, Sun and Liao 2011). Therefore, its necessary to evaluate the mechanism of change after taking AD and CV duties and to make a comparison on different AD and CV duties.

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China boasted a large production and import and export volume of forest products from 1961 to 2012 (Yang et al. 2014). China has been the largest exporter and the United States has been the largest importer in this increasingly globalized market (Luo et al. 2015). In 2016, there are 375 AD and CV duty orders in place and, among which, China has 140 cases (102 AD orders and 38 CV orders) out of 375 cases, which accounts for 37.33% of all AD and CV duty orders. While second largest country (India) has only 31 AD and CV duty orders¹. Besides, AD and CV duty investigations on imports of coated free sheet paper (Nos.701-TA-444-446, and 731-TA-1107-1109) was the first CV duty investigation of China. Additionally, China has become the leading exporter of wooden bedroom furniture (No. 731-TA-1058) which also involved in AD cases.

Based on the above description, some problems are going to be discussed: What is the influence on public firms of the U.S. on wooden bedroom furniture and coated free sheet paper cases? How does the stock market in a trading country react to AD and CV investigations? The objective of this study is to measure the AD and CV duties on the paper product (coated free sheet paper) and furniture product (wooden bedroom furniture) of China. This study extends the existing literature of market power related to the U.S. paper and furniture industry by conducting the comparison on two different forestry industries. Results will be helpful in understanding the different behavior in the U.S. paper and furniture industry.

LITERATURE REVIEW

There is an increasing trend of AD and CV actions during the past few years (Schuler et al., 2002; Feinberg and Reynolds, 2008). Blonigen (2003b) claimed that there were 2,200 AD cases worldwide in the 1990s, which rose from 1,600 cases in the 1980s and only a few cases in the 1970s (Blonigen 2003a). He also evaluated dumping margins of the U.S. increased from 15% to more than 63%, and the affirmative ruling probability increased from 45% to more than 60% from 1980 to 2000 (Blonigen, 2003b). Much research focused on analyzing the effects caused by AD and CV duties on firms, which showed AD and CV duties causing a significant change in business operation by exporting firms (Peng et al. 2008). AD and CV duties dramatically resulted in higher value of named forest products on exporting firms in order to decrease the dumping margin (Avsar 2013), which also led to the loss of competitive advantages on exporting firms (Brenton 2001, Ganguli 2008). Li et al. (2014) analyzed the effect of international business strategy and government assistance on the stock market response to AD and CV investigations. He also suggested that government assistance was as important as strategic restructuring to offset the negative effect of trade remedy investigations by using a sample of listed Chinese firms between 2006 and 2012 (Li et al., 2014). A previous study also evaluated and assessed the effects and benefits of pursuing trade protection (Marsh, 1998). While Prusa (1991) pointed out that firms would get trade protection even without pursuing the petition to complete. This was because firms would take AD petitions but withdraw later to achieve both agreements of quantity with foreign firms and government mediated price (Prusa, 1991). Ring et al. (1990) demonstrated that strategies used to pursue benefits from political activities and competitive strategies were interdependent (Ring et al., 1990). Schuler's (1996) study showed that the industry's largest firms dominated the politics surrounding trade protection in order to capture expected benefits from trade protection or to postpone high downsizing costs through modeling the determinants of corporate political activity as a single, multivariate phenomenon to examine the magnitude, scope, and timing of firms' use of political strategies to address U.S. trade policy (Schuler, 1996; Schuler et al., 2002).

Forest products firms that were publicly traded could be influenced not only by lawsuits in which they are directly involved, but also by court decisions on other firms in the industry (Sun and Liao, 2011). The U.S. forest products industry has witnessed an unprecedented period of mergers and acquisitions in recent years (Mei and Sun, 2008b). A widespread concern of the U.S. forest products industry was whether the ownership changes have improved the financial performance of these specific firms (Mei and Sun 2008a). Pesendorfer (2003) evaluated mergers and acquisitions in the U.S. paper and paperboard industry in the 1980s and claimed that most acquiring firms' efficiency increased after an acquisition (Pesendorfer 2003). Marsh (1998) offered an examination of impact related to managers to measure the effects of AD petition at several stages of the process by using the firm level of analysis (Marsh, 1998). Sun (2006) evaluated the duration of U.S. paper mills during the past 30 years. He found a hazard rate curve revealed increasing risk of closure for new mills at the first seven years and for established mills after 18 years (Sun, 2006). Li et al. (2004) pointed out that the growth and survival of U.S. pulp and paper mills mostly depended on age and size

¹ Data are obtained from anti-dumping and countervailing orders of USITC in 2016.

from 1970 to 2000 through using a micro-capacity database (Li et al., 2004). Luo et al. (2015) stated that AD duty against China in the U.S. generated a negative depression effect on China's exports to the United States and positive diversion effect on the exports from other countries (Luo et al. 2015).

METHODOLOGY

Events

The recent global economic crisis poses unique challenges for the world trading system, especially for the Sino-American trade relationship. The United States and China are held most responsible for the massive global economic imbalances that are thought to have bred the recent financial crisis itself (Ahn and Lee, 2011). China is a particularly useful starting point for a variety of reasons among all the countries who used AD and CV duties. It was the first leading target of AD and CV actions filed by other countries from 1995 to 2012¹. As China has agreed to the non-market economy designation in AD investigations, its non-market economy status has led U.S. AD authorities to apply more stringent criteria in AD investigations against China (Zeng and Liang, 2010). Specifically, there are 102 AD duty orders and 38 CV duty orders launched against Chinese firms out of 290 AD duty orders and 85 CV duty orders launched against all over the world in 2016².

Among the large number of AD and CV duties, China has become the leading exporter of wooden bedroom furniture in recent years (Kaplinsky et al., 2003). Total exports from China were \$46.83 million in 1992 but increased to \$4.51 billion in 2015. The United States has been the largest importer, with an import value of \$0.33 billion in 1992 and \$3.82 billion in 2015³ (Figure 1). The large exports from China have resulted in strong reaction from domestic manufacturers in the United States. In October 2003, a group of American furniture firms and labor unions filed a petition that alleged China's wooden bedroom furniture has been dumped in the United States at less than fair value to the USITC and DOC in the United States (U.S. ITC, 2004b). Final AD duties ranging from 0.83% to 198.08% have been imposed on individual Chinese firms since 2005 because it was concluded that wooden bedroom furniture imports from China materially injured the furniture industry (U.S. ITC, 2004a). In 2010, the AD duties have been retained as the same for a five-year review concluded that revocation of the AD duty order on China's wooden bedroom furniture would likely continue or recur to make material injury to the U.S. industry in a predictable time (U.S. ITC 2010).

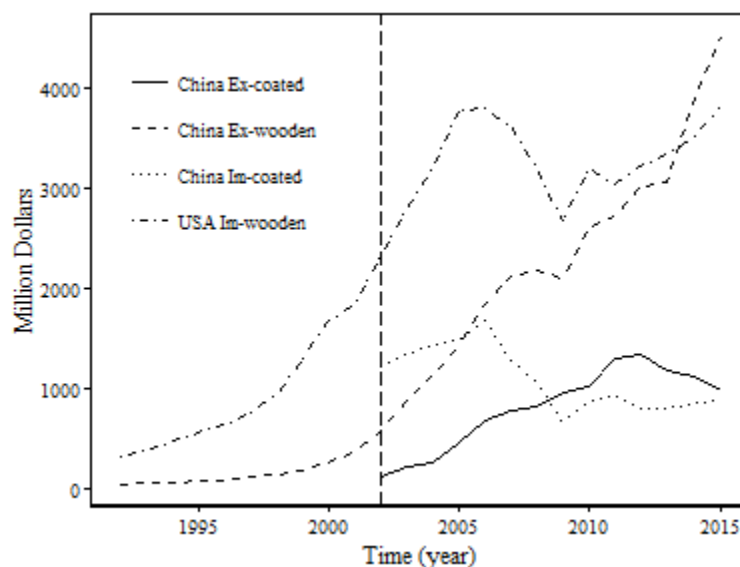


Figure 1. Trade value of China's export and USA's import on wooden bedroom furniture and coated free sheet paper. However, the first AD and CV duty investigations involving China since 1991 was happened on the imports of coated free sheet paper from China, which claimed that preliminary estimated of the net CV duty ranged from 10.9% to

¹ Data can be accessed at <http://www.wto.org/>.

² Data are obtained from anti-dumping and countervailing orders of USITC in 2016.

³ Data are obtained from UN Comtrade in 2016.

20.35%. (U.S. ITC, 2006; Ahn and Lee, 2011). The DOC released its final affirmative CV duty with net CV subsidy rates in the next phase of investigation, ranging from 7.40% to 44.25%. What's more, final AD duties ranging from 21.12% to 99.65% have been imposed on individual Chinese firms. The ITC announced its negative determination of injury in both the CV and AD investigations of CFSP on 7 December 2007 (U.S. ITC 2007). The import on coated free sheet paper of the United States has decreased from \$679.43 million to \$656.05 million, while the export on coated free sheet paper of China has steadily increased since 2002 (Figure 1). Given that the ITC issued a final negative injury determination, the proceeding was terminated and all estimated duties deposited or securities posted as result of the investigation were refunded or cancelled. Nevertheless, the significance of this case lies in the DOC's reversal of its longstanding policy of the non-applicability of CV duties to non-market economy countries and the applicability of the CV duty laws to allegedly subsidized imports from China (Ahn and Lee, 2011).

Table 1. Development of AD and CV investigation against wooden bedroom furniture and coated free sheet paper of China

Time	Wooden bedroom furniture events	Time	Coated free sheet paper events
20031031	DOC accepted petition	20061031	Petition filed
20031110	DOC started investigation	20061120	DOC initiation date
20031217	DOC issued a public notice to investigate	20061127	DOC's notices of initiation investigation
20040624	DOC published preliminary announcement	20061215	ITC preliminarily determination
20041117	DOC published final announcement	20061222	Commission views transmitted to commerce
20050104	DOC issued an AD duty order	20070109	DOC was restricted on this issue temporarily
20090226	DOC published review investigation	20070329	DOC issued an AD duty order
20091102	DOC published the notice of a sunset review	20070529	DOC announced affirmative preliminary investigation determination
20100813	DOC published the result of final administrative review (Fourth)	20071017	DOC announced to take both duties finally
20101130	DOC published notice to continue duty order	20071120	ITC proposed opposite vote
20110811	DOC decided to make a review	20071207	ITC announced its final determination
20120103	DOC requested an administrative review with anniversaries	20071210	Issuance of order by both DOC and ITC
20120229	DOC initiated an AD duty administrative review	20101022	DOC reviewed the case
20130130	DOC extended the deadline for the preliminary results of administrative review		
20130201	DOC revised deadline for the preliminary results of the administrative review		
20150128	DOC revised the result of final review		

Source: U.S. ITC and U.S. DOC.

Based on the above description of the development on AD and CV duties taken on wooden bedroom furniture and coated free sheet paper, there are many events which may affect the value of petition firms. This research chooses five

events of these two cases to analyze according to the importance of AD procedure after running all the events (Table 1). Five events of wooden bedroom furniture are: 20031217, 20040624, 20090226, 20091102, 20110811 and 20150128, respectively. Five events of coated free sheet paper are: 20061031, 20070109, 20070329, 20071017, 20071120, and 20101022, respectively.

Windows

AD investigation comprises three basic events: petition, initiation, and decision, which will affect the value of different public firms according to the specific events. The structure and statutory procedure of AD are shown in Table 2. A petition is filed by a company or a group of companies on behalf of domestic industry injured by dumped imports. To complete the procedure, the review process of AD petition can take as long as 10 to 14 months when the DOC determines that a petition satisfies all requirements under the law and publishes notice of initiation. Basically, the International Trade Commission (ITC) is responsible for making a preliminary injury determination within 45 days. The DOC will make a preliminary decision as the existence of dumping within 115 to 165 days of the filing if the ITC rules affirmatively. Then the DOC starts a final investigation no matter the preliminary decision because the purpose of a preliminary DOC decision is to notify the ITC whether to begin final investigation. An AD duty will be placed on imported products immediately if the ITC makes an affirmative ruling of injury. If both the DOC and ITC make affirmative findings, the DOC assesses duties against imports of that product as a percentage of the value of the imports and publishes a preliminary decision. The DOC final determination comes out 75 to 135 days later and the final event is the ITC final determination, which leads to the imposition of AD or CV duties within 45 to 75 days (Li et al., 2014).

Table 2. Statutory procedure of time on AD investigations in the United States

Items	Association	Periods (days)
Initiation	DOC	20
Preliminary investigation	DOC	115-165
Preliminary investigation	ITC	45
Final investigation	DOC	75-135
Final investigation	ITC	45-75
Administrative review	DOC	depends

Note: DOC denotes the U.S. Department of Commerce. ITC means International Trade Commission.

The periods of AD procedure may have small deviation according to specific events.

In the analysis of abnormal returns, an event window is composed of the event date and some period of time around the date. An estimation window is a period of time before the event window, which includes six alternative event windows: (-2, 2), (-3, 3), (-4, 4), (-5, 5), (-6, 6), (-7, 7). The width of the event window was 5, 7, 9, 11, 13, and 15 days (Sun and Liao, 2011). Pre-event and post-event windows need to be defined in the analysis of risk impacts. In this paper, there are three lengths to be examined (50, 100, and 150), which are consistent with previous study (MacKinlay, 1997).

Firms

Firms are selected from all the public petition firms, which are Ethan Allen Global, Inc. (ETH), Bassett (BSET), Hooker (HOFT) and Stanley Furniture Company, Inc. (STLY), which market manufacture bedroom furniture, and Glatfelter (GLT), International Paper Company (IP), Mohawk Industries (MHK), Sappi (SPP), which manufacture coated free sheet paper. The basic financial information of these public firms is shown in Table 3.

Data

The return of S&P 500 index is the proxy for the market portfolio, which is collected from CRSP database. The risk free of return is the secondary market rate for three-month U.S. Treasury bills from the Federal Reserve Bank (2008). All returns are expressed in percentage.

Method

Abnormal returns

Event analysis was a widely used tool to address these concerns because of its power in exploring linkages between events and firm values (Binder 1998, Wells 2004, Sun and Liao 2011). Various techniques of event analysis have been developed for addressing specific issues (MacKinlay 1997). The normal return is defined as the expected return, had the event not occurred

Table 3. Market value of firms related to AD cases in 2015 (Values in millions)

Events	Firms	Position	Total Asset	Total Equity	Total Revenue	Gross Profit
	ETH	No position	607.3	370.3	754.6	411.2
Wooden bedroom furniture	BSET	Petitioner	282.5	177.4	430.9	251.6
	HOFT	Petitioner	170.8	142.9	244.4	62.8
	STLY	Petitioner	63.1	47.7	57.4	13.7
	SPP	No position	65,066.2	13,442.3	71,383.4	9,230.8
Coated free sheet paper	IP	No position	30,587.0	3,884.0	22,365.0	6,897.0
	MHK	No position	9,942.4	4,854.2	8,071.6	2,410.7
	GLT	No position	1,503.6	663.2	1,666.7	203.0

Note: data are obtained from their stock markets <http://www.msn.com/en-ca/money/stockdetails/>.

$$R_{it} = \alpha_{it} + \beta_{it}R_{mt} + \varepsilon_{it} \quad (1)$$

where R_{it} is the return of firm i on day t ; R_{mt} represents the return of a market portfolio; α_i and β_i are the parameters to be estimated; t in this equation indexes a day over the estimation window; and ε_{it} is the mean zero disturbance term. In this study, the value-weighted S&P 500 Index was chosen as the proxy of the market portfolio.

$$E(\varepsilon_i) = 0 \quad (2)$$

$$Var(\varepsilon_i) = \sigma_{ei}^2 \quad (3)$$

The abnormal return is the actual return minus the normal return of the firm over the event window.

$$AR_{it} = R_{it} - (\widehat{\alpha}_{it} + \widehat{\beta}_{it}R_{mt}) \quad (4)$$

where t indicates a date over the event window in this equation ($t_1 \leq t \leq t_2$ or $1 \leq t \leq T$). Under the null hypothesis that the event has no impact on the returns, AR_{it} has a normal distribution (MacKinlay 1997). In actual estimation, AR_{it} is just the predicted residual of the market model on an out-of-sample basis.

$$CAR_i(T_1, T_2) = \sum_{t=T_1}^{T_2} AR_{it} \quad (5)$$

where $CAR_i(T_1, T_2)$ is the cumulative abnormal returns for firm i over event window (T_1, T_2) and indicates aggregation over time. If the event had no impact on the returns for the firm, the expected value of $CAR_i(T_1, T_2)$ should be zero.

$$Var(CAR_i(T_1, T_2)) = (T_1 - T_2 + 1) \sigma_{ei}^2 \quad (6)$$

when the estimation window is large, the variance of $CAR_i(T_1, T_2)$ can be asymptotically measured as above. Where T is the length of the event window and σ_{ei}^2 is the variance of the disturbance term in the market model.

$$\overline{AR}_T = \frac{1}{N} \sum_{i=1}^N AR_{it} \quad (7)$$

$$\overline{CAR}_{(T_1, T_2)} = \sum_{T=T_1}^{T_2} \overline{AR}_T \quad (8)$$

where $\overline{AR}_T$ is the average cumulative abnormal returns for N firms as a group over the T -day event window and it calculates the average across firms. With the assumption of asymptotically normal distribution, the variance of the

average cumulative abnormal returns ($\overline{AR}_T$) for the sample firms can be calculated and its statistical significance can be tested by the λ statistic as follows:

$$Var(\overline{AR}_T) = \frac{1}{N^2} \sum_{i=1}^N AR_i = (T_1 - T_2 + 1) \sigma_{ei}^2 \quad (9)$$

$$Var(\overline{CAR}_{(T_1, T_2)}) = \sum_{T=T_1}^{T_2} Var(AR_T) = \frac{T_2 - T_1 + 1}{N^2} \sum_{i=1}^N \sigma_{ei}^2 \quad (10)$$

$$\lambda = \frac{(\overline{CAR}_{(T_1, T_2)})}{\sqrt{Var(\overline{CAR}_{(T_1, T_2)})}} \sim N(0, 1) \quad (11)$$

This distributional result is asymptotic with respect to the number of firms and the length of the estimation window (Campbell and MacKinlay 1997).

Risks analysis

Market model considers the market-wide effect with a risk adjustment component, and is often employed for this purpose. The Capital Asset Pricing Model (CAPM) is often employed to measure the risk with the following econometric representation (Jensen 1969, Sun and Liao 2011):

$$R_{it} - R_{ft} = \alpha_i + \beta_i(R_{mt} - R_{ft}) + \mu_i \quad (12)$$

Where R_{it} and R_{mt} are realized returns at time t on asset i and the market portfolio m , respectively; R_{it} is the return on a risk-free asset at time t ; and the error term μ_i has normal distribution with mean zero, constant variance, and serial independence. The parameter β_i is often referred to as asset's beta and measures its systematic risk.

$$R_{it} - R_{ft} = \alpha_i + \beta_i(R_{mt} - R_{ft}) + \gamma_i D_i(R_{mt} - R_{ft}) + \mu_i \quad (13)$$

Where D_i is introduced as a dummy variable for firm i and γ_i is the parameter to measure the risk change. D_i has a value of one for the post-event window and zero otherwise. In this study, the risk-free asset was approximated by the return of 3-month treasury bills in the United States.

Results

Average cumulative abnormal returns of all the selected firms by case

The results of average cumulative abnormal returns (ACAR) of wooden bedroom furniture are shown in Table 4. The sign of the abnormal returns is consistent with the profit of forest firms around the periods of anti-dumping. The negative abnormal returns mean the forest firms lost, while the positive abnormal returns means the forest firms won. In this case, five of events (I, III, IV, V and VI) were statistically significant negative, while statistically significant positive was only observed for event II (Table 4).

For the statistically significant negative abnormal returns, event I was significant at -6.830% over the 13-day event window at the 10% level. For the negatively impacted events IV, V, and VI at the same significant level (5% level), the average abnormal returns were larger to -23.636% over a 15-day event window, -7.784% over a nine-day event window, and the smallest average abnormal returns of -4.793% over a five-day event window. At the significant level of 1%, there were two opposite signs of the abnormal returns: one had the largest negative average abnormal returns of -26.074% over a 15-day event window of event III, and another was the only positive average abnormal returns of 9.747% over a 15-day event window on event II.

The magnitudes of the cumulative average abnormal returns were different with different events. The more significant of the level, the larger magnitude of the cumulative average abnormal returns. Among all the negative events, the cumulative average abnormal returns of event III had the largest magnitude, which were -26.074% over fifteen-day event window at the 1% level. While the cumulative average abnormal returns of event VI had the smallest magnitude, which were -4.793% over a five-day event window at the 5% level. Besides, the magnitudes of the cumulative average abnormal returns are related to event window of different events. The longer of the event window, the larger magnitude it owns. For example, event III had the largest magnitude with the longest event window (15 days), while event VI had smallest magnitude with the shortest event window (five days) among the negative impacted events.

Table 4. ACAR on public firms of USA by AD case on wooden bedroom furniture of China

Event window	Value	I	II	III	IV	V	VI
5 days	ACAR	-2.599	1.391	-0.851	-8.426	-6.758**	-4.793**
	t	-1.138	0.578	-0.195	-1.523	-2.053	-2.219
7 days	ACAR	-2.570	5.216*	3.188	-5.595	-7.303*	-3.124
	t	-0.948	1.836	0.629	-0.851	-1.875	-1.226
9 days	ACAR	-8.172***	3.256	-6.257	-9.892	-7.784**	0.055
	t	-2.672	1.009	-1.119	-1.328	-1.764	0.019
11 days	ACAR	-7.598**	5.462	-13.877**	-19.061**	-3.944	1.719
	t	-2.246	1.537	-2.245	-2.322	-0.812	0.538
13 days	ACAR	-6.830*	7.527*	-16.593**	-22.299**	-2.270	2.073
	t	-1.864	1.947	-2.468	-2.495	-0.429	0.596
15 days	ACAR	-4.147	9.747***	-26.074***	-23.636**	-3.196	2.808
	t	-1.060	2.342	-3.680	-2.461	-0.564	0.750

Note: the abnormal returns were expressed in percentage.

* significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level.

Table 5. ACAR on public firms of USA by AD case on coated free sheet paper of China

Event window	Value	I	II	III	IV	V	VI
5 days	ACAR	-2.715*	2.078	2.837*	2.671*	-2.837*	-0.748
	t	-1.715	1.325	1.818	1.666	-1.747	-0.353
7 days	ACAR	-2.837	2.014	1.797	2.949	-5.356***	0.608
	t	-1.517	1.085	0.974	1.554	-2.791	0.243
9 days	ACAR	-3.557*	2.128	1.181	1.122	-4.905**	-0.360
	t	-1.678	1.012	0.564	0.522	-2.256	-0.127
11 days	ACAR	-4.141*	2.372	0.149	0.456	-4.835**	1.392
	t	-1.763	1.008	0.065	0.192	-2.003	0.442
13 days	ACAR	-4.867*	3.676	-0.231	0.005	-5.447**	1.063
	t	-1.899	1.427	-0.092	0.002	-2.092	0.310
15 days	ACAR	-4.114	5.375*	0.254	0.611	-3.614	1.151
	t	-1.493	1.947	0.094	0.220	-1.300	0.312

Note: the abnormal returns were expressed in percentage.

* significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level.

The results of average cumulative abnormal returns of coated free sheet paper are shown in Table 5. In this case, two events (I and V) were statistically significant negative, while statistically significant positive was observed on event II, III and IV. For the statistically significant negative abnormal returns, event I was significant at -4.867% over a 13-day event window at the 10% level. For the negatively impacted event V, the average abnormal returns were -5.447% over a 13-day event window at the 5% significant level. At the significant level of 10%, there were two positive average abnormal returns of 2.837% and 2.671% over five-day event window on event III and event IV,

respectively. For the statistically significant positive abnormal returns, event II was significant at 5.375% over a 15-day event window at the 10% level.

The magnitude of negatively impacted events (I and V) was larger than the magnitude of the positively impacted event III on average. Events I and V were significant, with longer event windows (13 days) than event III and event IV with the shortest event window (five days), and they also had larger magnitudes than event III and event IV. Besides, the 5% significant event V had a larger magnitude than the 10% significant event I, II, III and IV, which were -5.447%, -4.867%, 5.375%, 2.837% and 2.671%, respectively. Additionally, impacts on event VI were not statistically significant. The average abnormal returns of them were fluctuating between -0.748% and 1.151% over all the event windows, which has the smallest magnitudes overall.

The evolution of the cumulative average abnormal returns on the AD cases of wooden bedroom furniture and coated free sheet paper were demonstrated graphically in Figure 2. Both cases' events were represented by separate lines according to their significant estimates at their largest event window. For comparison, the scale of four panels were set at the same time. The left two panels were demonstrated for negative and positive average cumulative abnormal returns on the case of wooden bedroom furniture, while the right two panels were expressed for negative and positive average cumulative abnormal returns on the case of coated free sheet paper.

The trend of events on each case was different. For the AD case of wooden bedroom furniture, the trend of events I, II, III, V and VI was steady, while the trend of event IV fluctuated with the passing of time over the whole event window. The average abnormal returns of event IV decreased from 0.848% over a five-day event window to -23.636% over a 15-day event window. The line of event VI was shortest with the average abnormal returns of -4.793% over a five-day event window at a 5% level.

For the case of coated free sheet paper, five lines were draw with significant estimates at their largest event window. The trends of event I, II, III, IV, and V fluctuated over the event window. The overall trend of events I and V were decreasing with the passing of time from -0.615% and -0.198% to -4.867% and -5.447%, respectively. The line of the event III and IV were the shortest (only five-day event windows), which were increasing with the passing of time from 1.114% and 0.524% to 2.837% and 2.671%, respectively. The trend of event II fluctuated from 1.597% to the largest abnormal returns of 5.375% at the 15-day event window.

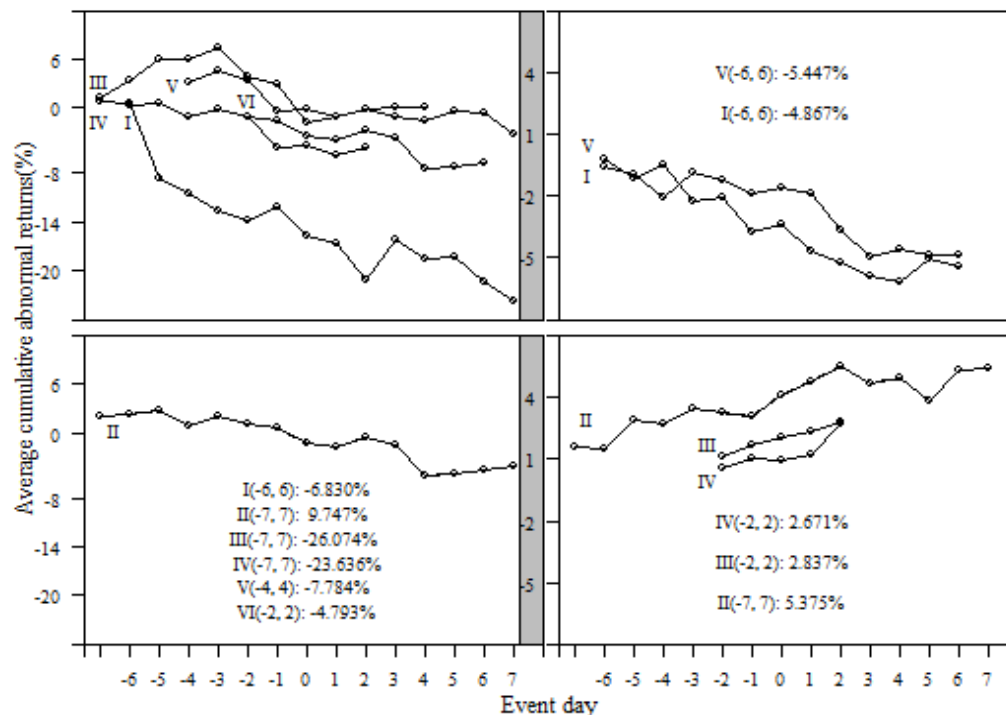


Figure 2. ACAR of AD measures over an event window on the case of wooden bedroom furniture and coated free sheet paper.

Compared with these two AD cases, it's obvious that the magnitude of cumulative average abnormal returns of wooden bedroom furniture case are larger than the cumulative average abnormal returns of coated free sheet paper. The most negatively impacted event of wooden bedroom furniture events is -26.074% , while the most negatively impacted event of coated free sheet paper is only -5.447% . The difference between these two negative events is almost five times. Besides, the largest positive average abnormal returns of wooden bedroom furniture case and coated free sheet paper case are 9.747% and 5.375% , respectively. Additionally, there are six significant events in the case of wooden bedroom furniture, while there are only five significant events in the case of coated free sheet paper. And the number of positive and negative impacted events are different.

Risk analysis of the selected firms during the cases

The results of risk estimates of wooden bedroom furniture and coated free sheet paper are combined in Table 6. Three lengths for the pre-event and post-event windows were examined: 50, 100, and 150 days. According to the risk estimates of wooden bedroom furniture case, event III generated positive estimates of γ_i for firm ETH, indicating this firm became more risky than the overall market after the case announcement when post-event window equals 150 days. There was one positive risk estimate (ETH) and one negative estimate (HOFT) generated by event VI, which means the firm ETH had a larger risky than the overall market, while the risk of the firm HOFT was decreased after the case announcement. Besides, when combining values of β_i and γ_i , the results of firm ETH from event III and event VI, when the post-event windows equaling 150 days were more than one, means firm ETH became riskier than the overall market after the case announcement. Additionally, event VI decreased risk for firms in general because the magnitude of the risk estimate of firm HOFT (negative) was larger than firm ETH (positive). While event III only increased risk for firm ETH. No significant risk estimate when the post-event window equals 100 days. When the post-event window equals 50 days, only event II generated negative estimates of γ_i for firm BSET, indicating this firm became less risky than the overall market after the case announcement. Event II only reduced risk for firm BSET for it generated negative risk estimate.

According to the risk estimates of coated free sheet paper case, the change of risk is shown as follows: when the post-event window equals 150 days, both event II and III generated negative estimates of γ_i for firms IP and GLT, indicating this two firms became less risky than the overall market after the case announcement. There were two negative risk estimates (GLT and SPP) generated by event IV, which means the firms GLT and SPP were less risky compared with the overall market. Therefore, event II, III and IV reduced risk for firms. When the post-event window equals 100 days, only event IV generated a negative estimate of γ_i for firm GLT, indicating this firm became less risky than the overall market, which means event IV reduced risk for firms. When the post-event window equals 50 days, event IV had a negative estimate of γ_i for firm GLT, while event V generated a positive estimate of γ_i for firm MHK. Event III reduced risk for firms, while event V increased the risk for firms.

It's necessary to analyze the relationship between risk returns and cumulative average abnormal returns. For the case of wooden bedroom furniture, event VI decreased risk for firms in general because the magnitude of the risk estimate of firm HPFT was larger than firm ETH. Event III only increased risk for firm ETH because it increased the risk of firm ETH and event II only reduced risk for firm BSET because it generated negative risk estimate. According to the cumulative average abnormal returns analysis, event III had the largest magnitude of -26.074% over a 15-day event window at the 1% level among all the negative events, which also increased risk for firm ETH. While event VI had the smallest magnitude of -4.793% over a five-day event window at the 5% level. But it did change the risk of firms, which decreased risk for firms in general. What's more, event II had the only positive average abnormal returns of 9.747% over a 15-day event window at the 1% significant level, and it also reduced risk for firm BSET. For the case of coated free sheet paper, events II, III and IV reduced risk for firms, while event V increased the risk for firm MHK. According to the cumulative average abnormal returns analysis, events II, III and IV had positive cumulative average abnormal returns of 5.375% over a 15-day event window, 2.837% over a five-day event window and 2.671% at the 10% significant level, respectively. All of them decreased the risk for firms. Event V had the largest negative cumulative average abnormal returns of -5.447% over a 13-day event window at the 5% significant level and increased the risk for firm MHK.

Table 6. Risk analysis of public petition firms of USA during AD and CV cases

Event	Intercepts	Post-event Windows	Case I				Case II			
			BSET	STLY	ETH	HOFT	IP	GLT	MHK	SPP
I	β_i	50	0.877***	0.842***	1.041***	0.367	1.134***	1.651***	1.123***	1.183***
		100	0.874***	1.035***	1.034***	0.841***	1.219***	1.473***	1.136***	1.110***
		150	0.897***	0.983***	1.025***	0.905***	1.219***	1.478***	1.074***	1.217***
	γ_i	50	0.170	0.229	-0.010	0.545	0.057	0.106	-0.041	0.186
		100	0.227	-0.044	0.052	0.119	-0.094	0.037	-0.112	0.353
		150	0.124	-0.026	0.018	0.035	-0.160	-0.325	0.138	0.302
II	β_i	50	1.168***	0.957***	1.074***	0.942***	1.324***	2.036***	0.982***	1.202***
		100	1.123***	0.934***	1.051***	0.981***	1.162***	1.535***	1.211***	1.063***
		150	1.113***	0.963***	1.065***	0.916***	1.250***	1.511***	1.081***	1.250***
	γ_i	50	-0.309*	0.088	-0.107	-0.136	-0.097	-0.698	0.225	-0.071
		100	-0.221	0.102	-0.111	-0.120	-0.072	-0.159	0.193	0.486
		150	-0.148	0.067	-0.096	-0.042	-0.239*	-0.500***	0.043	0.231
III	β_i	50	1.021***	0.997***	1.011***	0.988***	1.296***	1.579***	1.180***	1.465***
		100	1.005***	1.001***	1.007***	1.002***	1.157***	1.576***	1.033***	1.149***
		150	1.004***	1.000***	1.004***	1.001***	1.222***	1.553***	1.067***	1.220***
	γ_i	50	0.031	0.054	0.057	-0.002	-0.235	-0.150	-0.162	0.127
		100	0.046	0.021	0.046	0.015	-0.158	-0.476	0.075	0.409
		150	0.018	0.005	0.054*	0.005	-0.237*	-0.596***	-0.086	-0.145
IV	β_i	50	0.956***	0.986***	1.036***	0.998***	1.077***	1.333***	0.967***	1.545***
		100	0.946***	1.011***	1.045***	1.001***	1.118***	1.503***	1.010***	1.483***
		150	1.000***	1.002***	1.035***	1.010***	1.117***	1.541***	1.042***	1.407***
	γ_i	50	0.035	0.005	-0.027	-0.006	-0.128	-0.590*	0.401	0.020
		100	0.046	-0.021	-0.034	-0.007	-0.150	-0.462***	0.044	-0.387
		150	-0.009	-0.016	-0.024	-0.018	-0.128	-0.535***	-0.044	-0.375*
V	β_i	50	0.994***	1.003***	1.003***	0.994***	1.029***	1.019***	0.929***	1.041***
		100	0.994***	1.003***	1.002***	0.996***	0.986***	1.018***	1.007***	1.010***
		150	0.996***	1.003***	1.002***	0.995***	0.988***	1.007***	1.014***	1.032***
	γ_i	50	0.006	-0.014	-0.013	0.007	0.013	0.080	0.287***	-0.061
		100	0.009	-0.008	-0.009	-0.001	0.005	-0.031	0.028	-0.036
		150	0.005	-0.009	-0.008	0.000	0.006	-0.021	0.019	-0.059
VI	β_i	50	1.010***	1.000***	0.999***	0.999***	1.000***	1.006***	1.021***	0.974***
		100	1.007***	0.998***	1.000***	1.000***	1.032***	0.995***	1.029***	1.004***
		150	1.005***	1.000***	1.000***	1.004***	1.011***	0.994***	1.026***	0.995***
	γ_i	50	-0.010	0.003	0.006	-0.010	-0.013	-0.023	-0.041	0.016
		100	-0.006	-0.002	0.006	-0.007	-0.021	0.004	-0.034	-0.013
		150	-0.004	-0.002	0.007*	-0.008*	-0.008	0.004	-0.026	0.005

Note: the risk estimates were expressed in percentage.

* significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level.

CONCLUSION

For the result on the case of wooden bedroom furniture, event II represents the date on which DOC published preliminary announcement and has the only positive average abnormal returns of 9.747% over a 15-day event window at 1% significant level, which means firms won and got benefit from this event. Wooden bedroom furniture companies in China would sell more to the USA if it is not profitable to export if AD duty works later. On the same way, firms in the U.S. that have cooperation with China or have transnational corporation in China would import more before AD duty works.

Petition firms lost value for other events in total because it existed trade diversion effect, which means other countries such as Vietnam, Indonesia, Mexico would export wooden bedroom furniture to United States instead of China. Besides, there is close cooperation between petition countries and China that affected the profit of these firms. For example, BSET closed all the Bassett plants and decided to focus on importing wood products from lower-wage factories in China¹. HOFT also imports an extensive line of wood bedroom, living room accents, dining room, home office and home entertainment furniture and some leather furniture from factories around the world, which include factories in Asia, Mexico and Central America². Additionally, the influence on firms could be reflected by the position of petition firms and the market value of these firms. If the market value of one firm is larger than others, the influence of AD on that firm will be less, and vice versa. ETH doesn't have position for a wooden bedroom furniture AD case even if other public firms supported. That's one important reason other firms lost value in later events. ETH owns the largest firm value among all petition firms, and it's even larger than the sum value of other petition firms. What's more, the demand of wooden bedroom furniture would decrease in the United States after the price went up after taking AD measures because wooden bedroom furniture is rich in elasticity. Therefore, the profit of petition firms in the U.S. in general would decrease.

For the result on the case of coated free sheet paper, event II and III with the positive average abnormal returns of 5.375% (15-day event window), 2.837% (five-day event window) and 2.671% (over five-day event window) represent the date on which DOC published preliminary announcement. It means firms won and got benefit from these events because coated free sheet paper companies in China would sell more to the USA and firms in USA that have cooperation with China or transnational corporations in China would import more during this period. Event IV represents the date on which DOC announced to take both duties and has the positive average abnormal returns of 2.671% over a 15-day event window at 10% significance level, which means firms won and got benefit from this event. It makes sense that the U.S.'s import on coated free sheet paper from dumping countries has decreased after AD and CV duties were taken. However, event I caused firms to lose value for its negative abnormal returns and contradicts the above analysis. The case of coated free sheet paper has its own specialty because it is the first CV duty investigation involving China since 1991, and there's no jurisprudential history of the applicability of U.S. CV duty law to non-market economies. Therefore, accused firms in China didn't take this case as important as other AD cases when the petition was filed at the beginning because they may not have believed it would be issued later.

Event V had statistically significant negative abnormal returns and then caused petition firms lost values after ITC proposed opposite vote for the following reasons: what comes first is that the profit of petition firms would decrease for its rich elasticity demand of coated free sheet paper. Secondly, there are other countries exporting wooden bedroom furniture to United States instead of dumping countries because of the trade diversion effect. Additionally, the influence on firms is related to the market value of petition firms. If the market value of the firm is larger than others, the influence of AD duty on that firm will be less, and vice versa. In this case, SPP has the largest market value of all, the influence on this firm would be small. Therefore, risk of firm SPP would be reduced for its negative risk estimate. While firm MHK has smaller value compared with firm SPP, so it has larger risk than the risk of SPP. However, firm GLT has the smallest value but with negative risk estimate in event II, III and IV. This is because GLT has frequent international operations with Germany, France, U.K., Canada, the Philippines, Russia, and China. It even has facilities and representative offices in Suzhou and Hongkong of China³. This can also be concluded as petition firms in USA and accused firms in China have cooperation with each other or all petition public firms on the case of coated free

¹ This can be accessed at <http://www.newyorker.com/business/currency/the-decline-of-an-american-furniture-maker>.

² This can be accessed at <http://www.hookerfurniture.com/aboutus.inc>.

³ This can be accessed at http://www.glatfelter.com/about_us/location.aspx.

sheet paper have invisible position instead of petitioner. The most important reason that result in petition firms lost value is the announcement of failure in this case.

DISCUSSION

The cases of wooden bedroom furniture and coated free sheet paper have same features. There would be positive and significant average cumulative abnormal returns before DOC published preliminary announcement. It's because accused firms in the case would try their best to export products to USA in case of AD measures carried out later. Besides, the average cumulative abnormal returns of petition firms would be negative and significant after DOC published preliminary announcement for the following reasons: first of all, both products are rich elasticity demand goods, which cause profit decrease when price increase after AD measures were taken. Besides, the influence on firms are related to the market value of them. If the market value of one firm is larger than others, the influence of AD on that firm will be less, and vice versa. Additionally, the position of petition firms could reflect the rule of value change. If firm has obvious positions, its risk will be larger than the firm which has no position. What's more, there are other countries exporting wooden bedroom furniture to United States instead of China because of trade diversion effect. There would be negative average cumulative abnormal returns when DOC accepted petition because "dumping" countries didn't take importance to the cases especially for the case on coated free sheet paper, which was the first CV duty investigation involving China and there's no jurisprudential history of the applicability of USA CV duty law to non-market economies.

However, there are some differences between the case of wooden bedroom furniture and coated free sheet paper. What come first is that the magnitude of average cumulative abnormal returns of coated free sheet paper is small than wooden bedroom furniture. According to **Table 3**, the value of petition firms on the case of coated free sheet paper is larger than the value of petition firms on the case of wooden bedroom furniture. Paper firms in USA has many industries while furniture firms have limited industry. Therefore, the value of furniture firms would evaluate more than paper firms. Additionally, the risk estimates on the case of coated free sheet paper are larger than the case of wooden bedroom furniture for the position of petition and the cooperation between them and the accused firms in China.

AD and CV duties are used as an alternative mechanism to protect domestic firms from possible injury by unfair international trade in this framework for the international trading system. Although the first AD and CV duties on coated free sheet paper of China were cancelled, ITC determined that revoking the existing AD and CV duty orders on coated paper suitable for high-quality print graphics using sheet-fed presses from China and Indonesia would be likely to lead to continuation or recurrence of material injury within a reasonably foreseeable time¹. According to the trend of using AD and CV duties as effective remedy actions against imports has become exceedingly popular. The trade relationship between the United States and China still needs further tracking and analysis.

¹ Obtained from https://www.usitc.gov/press_room/news_release/2016/er120611696.htm.

LITERATURE CITED

- Ahn, D., and J. Lee. 2011. Countervailing Duty against China: Opening a Pandora's Box in the Wto System? *Journal of International Economic Law* 14:329-368.
- Avsar, V. 2013. Antidumping, Retaliation Threats, and Export Prices. *World Bank Economic Review* 27:133-148.
- Binder, J. J. 1998. The Event Study Methodology since 1969. *Review of Quantitative Finance and Accounting* 11:111-137.
- Blonigen, B. A. 2003a. Evolving Discretionary Practices of Us Antidumping Activity. NBER Working Paper Series, National Bureau of Economic Research, Cambridge, MA,.
- Blonigen, B. A. 2003b. Food Fight: Antidumping Activity in Agricultural Goods. International Conference, Agricultural Policy Reform and the WTO: Where Are We Heading? , Capri, Italy.
- Brander, J. A., and B. J. Spencer. 1981. Tarriff and the Extration of Foreign Monopoly Rents under Potential Entry. *Canadian Journal of Economics* 14:371-389.
- Brenton, P. 2001. Anti-Dumping Policies in the Eu and Trade Diversion. *European Journal of Political Economy* 17:593-607.
- Campbell, J., Lo, A., and A. C. MacKinlay. 1997. Event-Study Analysis. Chapter 4 in the *Econometrics of Financial Markets* Princeton University Press.
- Feinberg, R. M., and K. M. Reynolds. 2008. Friendly Fire? The Impact of Us Antidumping Enforcement on Us Exporters. *Review of World Economics* 144:366-378.
- Ganguli, B. 2008. The Trade Effects of Indian Antidumping Actions. *Review of International Economics* 16:930-941.
- Gayle, P. G., and T. Puttitanun. 2009. Has the Byrd Amendment Affected Us Imports? *The World Economy* 32:629-642.
- Jensen, M. C. 1969. <Jensen 1969 Risk, the Pricing of Capital Assets, and the Evaluation of Investment Portfolios.Pdf>. *The Journal of Business* 42:167-247.
- Kaplinsky, R., O. Memedovic, M. Morris, and J. Readman. 2003. The Global Wood Furniture Value Chain: What Prospects for Upgrading by Developing Countries? The Case of South Africa. United Nations Industrial Development Organization, Vienna.
- Li, W., Z. Yan, and W. Sun. 2014. The Effect of Antidumping and Countervailing Investigations on the Market Value of Firms. *International Review of Financial Analysis* 36:97-105.
- Li, X., J. Buongiorno, and P. J. Ince. 2004. Effects of Size and Age on the Survival and Growth of Pulp and Paper Mills. *Journal of Forest Economics* 10:3-19.
- Luo, X., C. Sun, H. Jiang, Y. Zhang, and Q. Meng. 2015. International Trade after Intervention: The Case of Bedroom Furniture. *Forest Policy and Economics* 50:180-191.
- MacKinlay, A. C. 1997. Event Studies in Economics and Finance. *Event Studies in Economics and Finance* 35:13-39.
- Marsh, S. J. 1998. Creating Barriers for Foreign Competitors a Study of the Impact of Anti-Dumping Actions on the Performance of Us Firms. *Strategic Management Journal* 19:25-37.
- Mei, B., and C. Sun. 2008a. Event Analysis of the Impact of Mergers and Acquisitions on the Financial Performance of the U.S. Forest Products Industry. *Forest Policy and Economics* 10:286-294.
- Mei, B., and C. Sun. 2008b. Measuring Oligopsony and Oligopoly Power in the Us Paper Industry. *Global Change and Forestry: Economic and Policy Implications* 35:36-38.
- Peng, M. W., D. Y. L. Wang, and Y. Jiang. 2008. An Institution-Based View of International Business Strategy: A Focus on Emerging Economies. *Journal of International Business Studies* 39:920-936.
- Pesendorfer, M. 2003. Horizontal Mergers in the Paper Industry. *Rand Journal of Economics* 34:495-515.
- Prusa, T. J. 1991. The Selection of Antidumping Cases for Itc Determination. *Empirical Studies of Commercial Policy* University of Chicago Press:Chicago, IL, pp. 47-71.
- Reynolds, K. M. 2006. Subsidizing Rent-Seeking: Antidumping Protection and the Byrd Amendment. *Journal of International Economics* 70:490-502.
- Ring, P. S., S. A. Lenway, and M. Govekar. 1990. Management of the Political Imperative in International Business *Strategic Management Journal* 11:141-151.
- Schuler, D. A. 1996. Corporate Political Strategy and Foreign Competition: The Case of the Steel Industry. *Academy of Management Journal* 39:720-737.
- Schuler, D. A., K. Rehbein, and R. D. Cramer. 2002. Pursuing Strategic Advantage through Political Means a Multivariate Approach. *Academy of Management Journal* 45:659-672.

- Sun, C. 2006. Lifetimes of Us Paper and Allied Products Mills: Insights from a Duration Analysis. *Southern Journal of Applied Forestry* 30:5-12.
- Sun, C., and X. Liao. 2011. Effects of Litigation under the Endangered Species Act on Forest Firm Values. *Journal of Forest Economics* 17:388-398.
- U.S. Census Bureau. 2006. Quarterly Financial Report for Manufacturing, Mining, and Trade Corporations: 2006. U.S. Department of Commerce, Washington, D.C.
- U.S. Census Bureau. 2016. Quarterly Financial Report for Manufacturing, Mining, and Trade, and Selected Service Industries. U.S. Census Bureau, Washington, D.C. 20233.
- U.S. ITC. 2004a. Wooden Bedroom Furniture from China Investigation (No. 731-Ta-1058 Final). U.S. International Trade Commission, Washington D.C.
- U.S. ITC. 2004b. Wooden Bedroom Furniture from China Investigation (No. 731-Ta-1058 Preliminary). U.S. International Trade Commission, Washington D.C.
- U.S. ITC. 2006. Coated Free Sheet Paper from China, Indonesia, and Korea Investigation (Nos. 701-Ta-444-446 Preliminary) and (731-Ta-1107-1109 Preliminary). U.S. International Trade Commission, Washington D.C.
- U.S. ITC. 2007. Coated Free Sheet Paper from China, Indonesia, and Korea Investigation (Nos. 701-Ta-444-446 Final) and (731-Ta-1107-1109 Final). U.S. International Trade Commission. U.S. International Trade Commission, Washington D.C.
- U.S. ITC. 2010. Wooden Bedroom Furniture from China Investigation (No. 731-Ta-1058 Review). U.S. International Trade Commission, Washington D.C.
- Wang, X., and M. Reed. 2015. Trade Deflection Arising from U.S. Antidumping Duties on Imported Shrimp. Selected Paper prepared for presentation at the Southern Agricultural Economics Association's 2015 Annual Meeting, Atlanta, Georgia.
- Wells, W. H. 2004. A Beginner's Guide to Event Studies. *Journal of Insurance Regulation* 22:61-70.
- Yang, H., X. Zhang, and Y. Hong. 2014. Classification, Production, and Carbon Stock of Harvested Wood Products in China from 1961 to 2012. *BioResources* 9:4311-4322.
- Zeng, K., and W. Liang. 2010. Us Antidumping Actions against China: The Impact of China's Entry into the World Trade Organization. *Review of International Political Economy* 17:562-588.

Concurrent Session 2C Supply Chain

EFFECTS OF THE GREAT RECESSION ON PRIMARY AND VALUE-ADDED WOOD INDUSTRY SECTORS: A CASE STUDY IN LOUISIANA, USA

Richard Vlosky and Abhishek Bharad¹

ABSTRACT—In 2008 and 2015, matched studies were conducted to identify changes in the Louisiana primary and secondary wood products industries. Specifically, the objective was to see if these sectors had recovered from the economic recession of 2007-2008. Results show that from 2007 to 2014, the number of Louisiana primary mills was estimated to have declined 21.5% from 200 to 157, and the number of Louisiana secondary mills was estimated to have declined 22.5% from 458 to 354. As housing starts recovered, the percentage of remaining softwood and hardwood lumber mill respondents producing these products increased 49% and 46%, respectively. Total full-time employment in the primary sector is estimated to have declined 17%, and part-time employees declined 85% over this period. In the secondary sector, production of key products was essentially unchanged. Part-time employment declined 26%, but full-time employment increased 9%, likely due to the strength of the repair and remodel sector, which actually surpassed single-family housing starts as the number one demand sector for lumber in 2015.

Keywords: recession, wood products, Louisiana, primary sector, secondary sector

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POST-DISASTER TIMBER SALVAGE ALONG THE GULF COAST: A LATENT ANALYSIS APPROACH

Jason S. Gordon and John B. Auel¹

Abstract —The purpose of this project was to identify and make available new and existing information that will facilitate more effective response by individuals, organizations, and government entities when storms and other forms of catastrophic disturbance lead to unplanned influxes of downed timber and woody debris across the southeastern United States. To this end, the authors explored attitudes and behaviors of stakeholders regarding their post-storm timber salvage experiences. Findings are reported from eight focus group sessions with forestry decision makers, including landowners, loggers, foresters, and agency representatives. Data were analyzed using an iterative coding process that organized large quantities of text into fewer categories and identified emergent themes. Relationships between themes and categories were described within and across cases based on their concurrence, antecedents, or consequences. This technique was followed by a latent content analysis focusing on discovering underlying meanings and understanding the explicit versus euphemistic terms. Findings demonstrate how risk perceptions and disaster experience interact to construct social meanings for disaster and associated preparedness activities. Themes centered around economic limitations and opportunities, social networks in resource utilization, and diverse interpretations of the disaster event. Implications include value-added utilization options for woody storm debris that have been pursued in past storm events and lessons learned that can inform future decisions.

Keywords: Timber salvage, disaster response, forest landowners, Gulf Coast

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FACTORS AND TRENDS AFFECTING PENNSYLVANIA'S LOGGING INDUSTRY

Michael Jacobson, Aaron Lewis, and Josh Hersl¹

Abstract—Pennsylvania is the U.S. leader in hardwood lumber production. Loggers are a crucial sub-sector in the supply chain of wood products. Logger activities include harvesting and transporting wood products to a mill. Wood products range from high quality veneer wood to low-use pulp, pallet wood, and, more recently, biomass. The continued strength of the hardwood industry in Pennsylvania requires successful loggers. However, many of these manufacturers are family-owned small businesses that are vulnerable to fluctuations in lumber and stumpage markets and the general economy. Competition, globalization, mechanized technology, rising operating costs, insurance and workers compensation, labor shortages and market dynamics are just some of the issues facing the industry. Data from two state-wide surveys of loggers, in 2009 and 2016, provide crucial insights to the changes in the structure of the sub-sector and factors influencing logging businesses. The results suggest a typical logger is rurally located, a single operation with low-valued equipment, and not well-connected to internet or email. Most are independent contractors relying on one or two mills for contracts. Significant changes in the industry over the last seven years include average age of loggers, dependence on alternative income, and rising concerns about finding employees and operating costs. Many loggers avoided answering the worker compensation issues, suggesting it as a major policy concern. Results help develop strategies and policies to maintain the vital logging industry in Pennsylvania.

Keywords: loggers, Pennsylvania, workers compensation, longitudinal survey

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FACTORS INFLUENCING THE USE OF CONSULTING FORESTERS SERVICE BY NIPF LANDOWNERS

Sagar Godar Chhetri, Jason Gordon, Ian Munn, and James Henderson¹

Abstract—Because many Non-Industrial Private Forest (NIPF) landowners do not have expertise in forest management and marketing, they hire a consulting forester who helps landowners make critical decisions and encourages reforestation after final harvest. However, researchers and foresters have noted a large portion of NIPF landowners do not use the services provided by consultants. This paper describes research assessing NIPF landowners' willingness to employ a consulting forester. About 2,000 NIPF landowners were selected randomly from a tax roll mail list maintained by Mississippi State University. Participants were surveyed to determine their attitudes and behaviors regarding consulting foresters and to identify the characteristics of those landowners willing to employ consultants. Linear probability and binary probit models were used for analysis. Forest acres owned ranged from 3 to 2,500 acres with an average of 78 acres and their demographics reflected the literature on NIPF landowners. One-third of the landowners were willing to use a consulting forester to manage their forestland. NIPFs having larger forest tracts, high income, and high education levels were more likely to use a consulting forester. Age had a negative correlation with willingness to employ a consulting forester. Only 5% of landowners had a written forest management plan and 10% participated in forestry-related organizations. Cooperation and communication between consulting foresters and NIPF landowners would increase the quality and quantity of forest products from NIPF.

Keywords: Non-industrial private forest, employ, consulting foresters, services.

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Concurrent Session 3A Management

UTILITY MAXIMIZATION, LANDOWNER EFFORTS, AND OPTIMAL HARVESTING

Richard J. Brazee and Eric W. Green¹

Abstract—Many non-industrial private forest owners (NIPFs) do not harvest their forest stands as often as the Faustmann model recommends that they should. The standard explanation for the divergence between harvest recommendations from the Faustmann model and landowner behavior is that in addition to timber production, landowners value forest amenity values, and actually are maximizing land values. We propose an alternative explanation based on landowner utility rather than amenity values. Specifically, landowner effort is necessary to reach the optimal level of silviculture investment in a Faustmann-type model, and that for some landowners the required landowner effort has a high opportunity cost. To begin developing this explanation, we qualitatively analyze two simple utility models. In the first model a lifetime utility model in which a landowner's silvicultural efforts are optimized is developed. In the second model discounted utility is maximized with respect to silvicultural efforts. Although both models have flaws, each offers some insights. An important set of results trace possible implications of the opportunity cost of landowner effort on optimal harvesting.

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REGIONAL COMPARISONS OF ECONOMIC RETURNS ASSOCIATED WITH COMMONLY MANAGED SPECIES

Curtis L. VanderSchaaf¹

Abstract—The art and science of forest management is practiced on many acres in the Lake States, Pacific Northwest, and Southeast regions of the United States. These forests provide woody fiber for timber products, biomass for heat and electricity, recreational activities, wildlife habitat, etc. Timber for products such as pulp, oriented strand board, lumber, etc., are commonly harvested. This paper attempts to compare the economic returns of a few select, but widely managed cover types/species in these regions. The objective is to provide an example of how these types of analyses can help foresters, managers, planners, and governments determine competitive status of their forests. In today's global economy, it is important to realize that providing economic opportunities and incentives can produce investment in primary and secondary wood production facilities. Regional comparisons can help determine if local tax incentives and particular management regimes, such as extended forests, cover type conversions, etc., create an advantage or disadvantage to managing in a sustainable, but economically wise manner.

INTRODUCTION

Forestry is widely practiced in the Lake States, Pacific Northwest, and Southeast regions of the United States. Identifying the competitive productive status of Minnesota forests to those across the U.S. is important to help identify potential forest management and manufacturing investment opportunities. Given today's global economy, it is vital to understand that providing economic opportunities and incentives can produce investment in local primary and secondary wood production facilities and encourage landowners to keep, maintain, and/or manage their forests. For example, providing incentives may help to reduce factors such as fragmentation and parcelization that are widely occurring. Poor tax policies can discourage forestland investments and it has been found that minimum enrollment periods likely limit participation in landowner incentive programs.

The Future of Washington Forests project (<http://www.ruraltech.org/projects/fwaf/#final>) reports the state of Washington has one of the highest tax obligations in the nation for owning timberland and harvesting timber. How does this make owning forests in Minnesota more competitive? What is the relative status, and are there incentives that can be created to help promote investment in the state? Based on the 2007 Cost-of-Doing Business Index produced by the Milken Institute (<http://www.ppinyts.org/reports/jtf/costbusiness.html>), Washington ranked 15th, Oregon ranked 29th, while Alabama, Georgia, and Louisiana ranked 39th, 32nd, and 26th, respectively. Michigan and Wisconsin ranked 20th and 23rd, respectively. Minnesota ranked 13th. How might this influence investment in the state? The state of Minnesota does currently offer payments and tax incentives for conducting long-term forest management, the Sustainable Forestry Incentives Act (SFIA) and 2c Managed Forest Law, rules and qualifications differ. According to the Minnesota Revenue office, as of November 2015, the SFIA payment is \$7 per acre (but can vary depending on many factors), given limitations such as the use of an active forest management plan, no delinquent property taxes, a landowner owns 20 or more contiguous acres, etc.

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Over a 50-year rotation, and given this payment is a taxable income – thus for simplicity we can reduce it by 25 percent annually (assuming a 25% marginal income tax rate) to a payment of \$5.25 per acre, assuming a 3% interest rate, this would equate to a \$140 discounted revenue per acre. This revenue could be used to offset, for example, discounted regeneration costs in economic assessments.

Many large-scale wood using facilities have closed over the past 10 years in Minnesota. With these closings and curtailments of existing facilities, timber harvest amounts have been greatly reduced (Figure 1). For example, in 1999 3.82 million cords were harvested while in 2013 the level had dropped to 2.88 million.

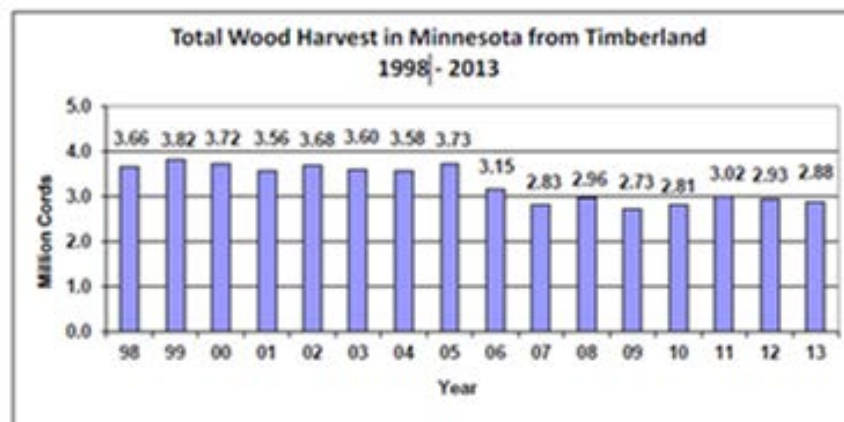


Figure 1. Total wood harvested (estimated) since 1998 in Minnesota. <http://files.dnr.state.mn.us/forestry/um/forest-resources-report-2015.pdf>

The Future of Washington Forests Project presented a figure showing sawmill production facilities. It is a telling story of the current relative status of sawtimber harvests in Minnesota. Another report also showed lumber production was and is projected to be relatively small for the Lake States compared to the U.S. West, U.S. South, British Columbia, and Eastern Canada (Wilent, 2014) for a period from 1990 to 2018. Their report indicates that European producers in Finland, Sweden, and others in Europe have the potential to place softwood lumber into eastern U.S. markets, depending strongly on exchange rates.

State of Washington

As noted in the Future of Washington Forests report, mill closures/curtailments and subsequent drops in harvest levels in turn limits the options of forest managers, particularly on the “Eastside” or, essentially, eastern Washington. For example, if a thinning to reduce stand density is needed to help reduce the probability of disease/infestation, yet there is no market for this wood and therefore no ability to recoup the costs associated with marking/appraising/setting up the timber sale, etc., can the activity be conducted — essentially the thinning operation is merely a cost. Thus, at some point management only becomes economically viable for such things as reductions in fire risk. This can be seen in states such as Colorado and Wyoming which have limited markets and hence landowners have less ability to recoup their management costs; thus, forest management has been reduced.

Average stumpage prices in 2012 for the Westside (SVA’s 1-5) were \$376 per MBF Scribner, while for the Eastside (SVA 6) they were \$149 per MBF Scribner. Firstly, there are fewer facilities in eastern Washington (and Oregon), hence the average haul distance is much greater for forests in this region compared to forests in western Washington and Oregon, this can greatly reduce stumpage prices. Secondly, stumpage differences could also be due to factors such as lower productivity in eastern forests and thus harvesting operations could be slightly less efficient, etc., stem

form could be a factor plus species compositions, etc. In 2017, average stumpage prices are \$391 per MBF Scribner and \$259 per MBF Scribner for the Westside and Eastside, respectively. Hence, at the current time, the Eastside has gained some competitive advantage but lags far behind in terms of average stumpage prices. Are there incentives that the State of Washington can provide to help promote the forest industry in the eastern part of the state?

Places such as northwestern Minnesota currently have limited markets despite relatively good individual site timber access. Much of the timbered stands are intermixed with agricultural sites, and road infrastructure is relatively good compared to other parts of the state. In large part due to long haul distances, particularly given the current market situation, facilities such as Boise Inc. have reduced their “timbershed” and don’t need to buy wood from areas like Roseau. Thus, it can be somewhat difficult to pay for, justify or recoup the costs of forest management in this part of the state. Yet, management needs to occur. The DNR has considered selling aspen (*Populus tremuloides* and *Populus grandidentata*) at lower stumpage values to provide an incentive — even so, these acres are still marginal. Perhaps given the recent curtailment announcement at Boise Inc., these lands will likely become even more marginal or outright economically infeasible. How might low stumpage values and low demand impact a private landowner’s ability to manage their forest in this part of the state?

State of Idaho

In a 2001 timber supply analysis for southwestern Idaho, titled *An Analysis of Timber Supply and Future Timber Markets for Southwestern Idaho*, (<http://www.nnrg.com/pdfs/003.pdf>) they report the closing of six mills (four were owned by Boise Cascade) in this region from 1995 to 2001, reducing consumption from around 400,000 to 500,000 cords, with only one smaller sawmill remaining with an annual usage capacity of around 100,000 cords open. There are many important statements in this report. One is at that time Boise Cascade was going to send their logs harvested in Idaho to their facilities in Oregon. Second is that the Idaho Department of Lands had restrictions on how much wood harvested from their lands could be shipped to facilities in Oregon, and perhaps an extremely important one for Minnesota given the current market:

“We are all learning the painful lesson that the economic laws of supply and demand can nullify the best land management plans.”

Pacific Northwest

Douglas-fir (*Pseudotsuga menziesii*) has been widely planted in the Pacific Northwest, both along the Coast and in the interior areas, often referred to as the Inland Northwest. Simmons et al. (2016) refer to these geographic regions in Oregon, for example, as the Western and Eastern regions, but other names include Eastside and Westside in Washington. In the states of California, Oregon, and Washington, FIA reported 8.1 million acres were planted while FIA estimates 79,000 acres have been planted in Idaho and Montana, in total around 8.2 million acres are classified as plantation on forestlands.

On the Westside, planting densities are now much lower relative to the past, generally around 400 seedlings per acre, Talbert and Marshall (2005) report an average of 435 seedlings per acre but stated some plantations are established on 11-feet by 11-feet spacings, producing a nominal 360 seedlings per acre. An economic assessment conducted for the Future of Washington Forests project compared various silvicultural treatments using a planting density of 435 per acre. Since planting density has dropped, the use of precommercial thinning (PCT) has also decreased, for this current analysis no PCT was assumed. Due to lower demand for larger diameter trees and better utilization of smaller diameter trees, they state commercial thinning is not as popular as in the past and perhaps does not produce as much economic advantage as once thought. The Future of Washington Forests project actually found unthinned Douglas-fir plantation management scenarios economically superior to thinned scenarios. Hence, the economic assessment for Douglas-fir will assume no thinning.

Douglas-fir is the most widely harvested species in the Pacific Northwest states of Oregon and Washington (e.g., http://file.dnr.wa.gov/publications/em_obe_wa_timber_harvest_2015_final2.pdf, Simmons et al., 2016), and second

in Idaho (Simmons et al., 2014) and Montana (McIver et al., 2013). Since a majority of the Douglas-fir harvested is from forests in Oregon and Washington, and since much of this volume is from industrial lands (e.g. Simmons et al., 2016), a management scenario reported as common in the literature for industrial lands in these regions will be used. This rotation is essentially the same as that used during The Future of Washington Forests project.

Lake States

Aspen, commonly referred to as the Aspen/Balm of Gilead cover type (ABg), and Red Pine Plantations (RPP – *Pinus resinosa*) are two cover types commonly managed and harvested in the Lake States. For this analysis, outside of the ABg cover type, only plantations will be examined.

Due to relatively fast growth rates, high yields, and low regeneration investment, ABg stands provide an economically competitive alternative nationally for the Lake States, and more specifically Minnesota. Additionally, according to the USDA Forest Inventory and Analysis (FIA) program, it is the dominant cover type in Minnesota, comprising nearly 30% of the timberland acreage across the state. It is extremely important to several individual mills in Minnesota, accounting for more than half of all harvested wood. Aspen is sold as pulpwood and utilized by several engineered and paper mills within Minnesota, and it is used to a relatively small degree by sawmills.

Some management agencies, such as the Minnesota DNR Division of Forestry, are trying to reduce ABg acreage through conversion to increase species spatial diversity. However, when looking at regional/global economic considerations, ABg cover type may provide an extremely attractive forest management option.

Red Pine Plantations (RPP) develop relatively slower than Aspen and often require greater regeneration investments, but at mid-rotation, yields can greatly exceed ABg stands and much of the wood is in higher value products such as sawbolts and sawtimber, unlike the ABg cover type where much of the volume is pulpwood material throughout the entire rotation. Additionally, around three to six commercial thinning operations can be conducted in a RPP rotation, producing earlier returns – first thinnings can occur at ages of 25. However, in general, final clearcut economic rotation ages are often slightly longer than ABg. There are many issues related to the RPP cover type.

For instance, issues with deer browsing of seedlings, which requires bud capping and increases reforestation costs, the desire for extended rotation management of this cover type on public lands, lack of a strong pulpwood market, etc. Due to slower growth rates compared to species such as loblolly pine (*Pinus taeda* L.), seedling costs can be much greater, and since growth rates are slower and, therefore, economic returns occur at older ages, natural regeneration has been proposed to maintain this cover type. However, there has been extreme difficulty in regenerating natural stands due to issues such as *Diplodia*. Alternatively, to reduce regeneration costs, some agencies are currently seeding rather than planting red pine. Contrary to usual convention, red pine trees at some point can actually become less valuable as they increase in size – large sawlog size trees are not suitable for utility poles and they are not usable by current sawmills designed for mid-sized logs. Hence, given current markets, extended rotations not only decrease returns because of the influence of economic discounting and reduced growth rates at older ages, but also reductions in stumpage values as trees get 20 inches or larger in DBH.

Minnesota has relatively fewer acres of RPP relative to the other Lake States (Table 1). Most acres are near the first or second thinning stage (e.g., ages of 21 to 60) in Minnesota and Wisconsin. Depending on the agency and management philosophy, many acres in Michigan are near final harvest. Michigan has the greatest amount of volume (when excluding site quality considerations) that can be final harvested now and within the next 10 years (ranging from around ages 55 to 90 if economic maximization regimes are practiced), while Wisconsin has the greatest volume within the range of 20 to 45 years. Minnesota lags far behind both Michigan and Wisconsin in terms of the amount of volume that can be final harvested within the next 10 years. However, in 30 or 40 years Minnesota will be at a much greater competitive level in terms of volume obtained from red pine plantations. Changes in policy in Minnesota, such as the retraction of the Extended Rotation Forestry (ERF) policy for the DNR and perhaps issues with Trust lands, may result in shorter RPP rotation ages, with much more limited extended rotation acreage.

Table 1. Estimated number of red pine planted acres ACROSS ALL OWNERSHIPS by age-class within the Lake States according to the most recent FIA surveys. Miles, P.D. Tue Mar 14 14:54:39 CDT 2017. Forest Inventory EVALIDator web-application Version 1.6.0.03. St. Paul, MN: U.S. Department of Agriculture, Forest Service, Northern Research Station. [Available only on internet: <http://apps.fs.fed.us/Evalidator/evalidator.jsp>]

	Total	0-20	21-40	41-60	61-80	81-100	100+
Michigan	700,332	86,509	92,594	300,515	209,790	10,924	-
Minnesota	361,115	60,273	137,595	116,861	22,657	13,145	10,583
Wisconsin	632,487	111,587	236,428	194,098	80,697	5,752	3,925

Southeast

Loblolly pine is the most widely planted species in the southeastern portion of the U.S. According to recent FIA estimates, for an area ranging from Texas and Oklahoma to Virginia, around 48.2 million acres have been planted. This species grows relatively quickly, and yields are fairly high at younger ages. Thus, rotation ages are relatively low compared to species grown in other regions of the U.S. and many mills, similar to aspen in the Lake States, have adopted their processing to the characteristics of this species. However, when compared to ABg, these stands require relatively large regeneration investments.

Relative to red pine and Douglas-fir, genetically improved loblolly bareroot seedlings cost much less. Prices per thousand for bare-root loblolly pine range from around \$55 to \$80. For red pine they are around \$250 per thousand, and they are around \$330 and in some cases even \$600 per thousand for Douglas-fir depending on seedling type. Early growth rates are better for loblolly, reducing its rotation ages. Additionally, unlike red pine, loblolly pine has a strong pulpwood market (e.g. Piva et al. 2014). Douglas-fir has a relatively smaller pulpwood roundwood tree market (Future of Washington Forests, McIver et al., 2013; Simmons et al., 2014; Simmons et al., 2016).

The comparison of these three regions and species are particularly important to Minnesota at this time given that Potlatch Corporation, a REIT, and Molpus Woodlands Group, a TIMO, both own land in these three regions — although almost all western U.S. ownership is in the Inland Northwest or Eastside. In 2012, Molpus purchased timberlands from Forest Capital Partners, LLC. This sale included 286,000 acres in Minnesota, 110,000 acres in Louisiana, and 138,000 acres in Idaho. Molpus is based out of the southeastern U.S. (Hattiesburg and Jackson, Mississippi) while Potlatch is based out of Spokane, Washington. Potlatch owns 159,000 acres in Minnesota with a fair amount of aspen and red pine. They own around 410,000 acres in Arkansas, 96,000 acres in Alabama, and 98,000 acres in Mississippi which are mainly southern yellow pine (majority being loblolly) and around 617,000 acres in Idaho that contain a fair amount of Douglas-fir.

Additionally, Norbord operates facilities in Solway, and one OSB facility each in the states of Alabama, Georgia, Mississippi, South Carolina, and two OSB facilities in Texas. Louisiana-Pacific (LP) operates a siding manufacturing facility in Two Harbors, it also operates similar facilities in Hayward and Tomahawk, Wisconsin, Newberry, Michigan, and one in North Carolina. It also has other composite manufacturing facilities in Alabama, Michigan, North Carolina, and Texas. Boise Inc. recently announced an investment of \$111 million dollars for a conversion in their DeRidder, Louisiana, plant — the Louisiana Department of Economic Development offered several tax incentives and an economic development award. Apparently, company sites in several other states were competing for this investment by Boise Inc.

METHODS

For all species, timber appraisal costs were ignored, and area-specific tax considerations were also ignored. More detailed analyses would likely incorporate existing forest management payments, reimbursement, and tax incentives,

plus incentives for ecosystem services, etc. As part of a sensitivity analysis, interest rates, or alternative rates of return, were varied. Based on current FIA data used to estimate an area-weighted average site quality, a site index of 65 feet (base age 50) was selected for both ABg and RPP.

Aspen/Balm (ABg)

Model forms presented by Walters and Ek (1993) and refitted using more recent data were used to obtain per acre cover/forest type volume estimates, upper stem diameter outside bark (DOB) was 4 inches. Regeneration costs were assumed to be zero. No mid-rotation treatments were used. Due to “real world” merchantability restrictions, the youngest potential clear-cut age was 40 years.

Red Pine Plantation (RPP)

Models presented by VanderSchaaf and Deckard (2012) were used to obtain per acre cover/forest type volume estimates, these equations were fit using MN DNR Forest Inventory Module (FIM) data updated in February 2012, specific merchantability limits cannot be determined since reported volumes were used in developing volume equations and therefore merchantability limits are timber appraiser/stand specific. Projections were verified against other available growth and yield simulators.

Discounted regeneration costs were assumed to be \$575 per acre. These costs include \$150 per acre for site preparation, \$225 per acre for seedlings and planting (which corresponds roughly to 600 seedlings per acre), \$80 per acre for a release treatment in year 1, and \$40 per acre to conduct bud capping in years 1, 2, and 3 to reduce deer browsing.

Up to six thinnings, beginning at age 25, and occurring every 10 years, were conducted. Each thinning generated 10 cords per acre — on average, this is a reasonable assumption based on independent analyses. The earliest age of a final harvest was age 50, at least ten years had to pass after a particular thinning before a final harvest could occur. Thus, at age 50, only two thinnings could occur (ages 25 and 35) since a thinning at age 45 could not occur, while a final harvest at age 55 also included a thinning at age 45 because 10 years would have passed, etc.

For both ABg and RPP, estimates were then separated into individual species volumes by using statewide average species compositions (Table 2) estimated using FIA data and then stumpage values were assigned by individual species based on current Minnesota public stumpage rates — weighted by relative amounts for each species of harvested wood going to either pulpwood, pulpwood and bolts, or sawtimber.

Table 2. Percent species compositions by MN DNR Cover Type and MN DNR stumpage values. Only plots found on MN DNR land and defined as TIMBERLAND by FIA standards were used to determine average species compositions. All live volume was used (includes rough, rotten, and merchantable volume – as defined by FIA).

Clearcut		Species Groups																
Cover Type	Jack Pine	Red Pine	Eastern White Pine	Balsam Fir	White Spruce	Black Spruce	Tamarack	NWC	Quaking Aspen	Bigtooth Aspen	Balm	Paper Birch	Basswood	Red Oak	White Oak	Elm	Maple	Ash
RPP	0.93%	92.93%	2.95%	0.11%	1.14%	0.00%	0.00%	0.00%	1.06%	0.06%	0.00%	0.20%	0.01%	0.29%	0.06%	0.00%	0.07%	0.00%
ABg	0.45%	0.09%	1.49%	5.43%	2.22%	1.46%	0.66%	2.70%	54.85%	4.19%	9.63%	6.35%	0.44%	1.55%	1.17%	0.32%	4.27%	2.49%
Thinning		Species Groups																
RPP	3.67%	88.95%	0.79%	0.55%	1.56%	0.10%	0.06%	0.01%	2.97%	0.06%	0.09%	0.41%	0.04%	0.05%	0.17%	0.00%	0.01%	0.01%
Stumpage Values 2015																		
All	\$27.89	\$39.48	\$31.24	\$16.45	\$21.11	\$24.00	\$8.32	\$6.69	\$36.11	\$36.11	\$17.87	\$16.61	\$13.57	\$33.27	\$33.27	\$8.70	\$17.86	\$7.26

Loblolly Pine Plantation

A growth and yield simulator titled Ptaeda 4.0 was used to obtain projections. A site index of 70 feet (base age 25) on the Coastal Plain was assumed, site preparation was chop, burn, and bed, with a first-year herbaceous weed control treatment. The drainage class selected was well-drained and no fertilization at planting treatments were conducted. A planting density of 436 seedlings per acre was selected (10 feet by 10 feet). A cost of \$65 per thousand seedlings was assumed, based on review of seedling prices from several state nurseries in the southeastern U.S. Also assumed was a weighted by acre cost of \$0.09 per seedling to plant by hand and machine (Barlow and Levendis 2015). Site preparation and first-year herbaceous weed control costs of \$96 and \$14 per acre were assumed, respectively.

Thinnings from below were conducted at ages 12 and 20, residual basal area was 65 square feet per acre at age 12 and 70 at age 20. Minimum dbh for pulpwood, chip-n-saw and sawtimber were 4, 9, and 12 inches, respectively. For pulpwood, chip-n-saw, and sawtimber, the upper stem outside-bark diameter limits were 2, 4, and 8 inches, respectively. For chip-n-saw and sawtimber size trees, all volume above either a 4 in. or an 8-inch top, respectively, was classified as pulpwood (to a 2-inch top). A conversion of 2.6 tons per cord was assumed. Stumpage revenues of \$10, \$17, and \$24 per ton for 4th quarter 2016 (<http://www.timbermart-south.com/prices.html>) were used for pulpwood, chip-n-saw, and sawtimber, respectively. Roughly equivalent to \$26, \$44, and \$62 per cord for pulpwood, chip-n-saw, and sawtimber, respectively.

A fertilization treatment was assumed to occur after the thinning at age 12 when the projected stand was 13 years old, a cost of \$79 per acre was used (Barlow and Levendis, 2015). Additionally, a mid-rotation release treatment at age 13 was utilized with an assumed cost of \$42 per acre. To represent the impacts of the fertilization and release treatments on residual trees, a fertilizer response of 25% of estimated harvested yields from Ptaeda at the second thinning was assumed (Dickens et al., 2003; Miller, 2017). This management scenario is representative of industrial management regimes in 2017, of course local markets can justify different management regimes.

Douglas-fir Plantation Westside

The Douglas-fir plantation scenario is based on the Future of Washington Forests analysis and average Westside industrial forest land practices based on a survey of industrial landowners presented in Briggs (2007). A treatment regime of planting 436 seedlings per acre (Briggs, 2007, reported an average of 462 seedlings per acre in 2005), a weighted site preparation method, and vegetation control in year 1 was selected. Based on Briggs (2007) and reported in Marshall and Turnblom (2005), an average site index (base age 50) for private Douglas-fir lands is 118 feet.

A growth and yield simulator titled DFSIM (Douglas-fir Simulator - <http://www.fs.fed.us/pnw/software/>

[DFSIM14/DFSIM.htm](#) — e.g. Curtis et al., 1982) was used to obtain projections — the default maximum Relative Density value of 70 was used. This simulator was created using data from plantations established in the 1960s and

1970s and earlier, and thus may not be entirely representative of plantations established in the 80's and 90's and especially more recently given advances in planting stock, genetic stock, site preparation, vegetation control, etc. Marshall and Turnbull (2005) showed that DFSIM underpredicted yields by nearly 40% compared to a simulator entitled TreeLab (http://www.cfr.washington.edu/research.smc/treelab/Website/TreeLab_home.htm), developed using more recently established plantations. When compared to Organon V7 and Organon V8, DFSIM also underpredicted (www.growthmodel.org/papers/marshall081005.ppt). Hence, to be somewhat compatible with newer simulators, DFSIM projections were increased by 30%, however, this doesn't necessarily address "faster" stand development — thus economic rotation ages as used in this analysis could be slightly longer than what would be observed on more recently established plantations.

Site preparation costs were a weighted average based on Briggs (2007) – 69% chemical at a cost of \$69 per acre, 27% pile and burn at a cost of \$140 per acre, and 4% broadcast burn at a cost of \$205 per acre, producing a weighted average of \$93.35 per acre. A cost of \$520.00 per thousand seedlings was assumed, a weighted price based on review of seedling prices from Washington DNR Webster Forest Nursery and Briggs (2007), 50% P+0 stock at a cost of \$585 per thousand and 50% 1+1 stock at a cost of \$455 per thousand. The Webster Nursery did not report the sale of P+1 seedlings despite it being the predominant seedling type planted as reported by Briggs (2007). Weyerhaeuser reported prices of \$625 and \$585 per thousand 1+1 seedlings in Oregon and Washington, respectively. Hence, an assumed price of \$520 per thousand seedlings is somewhat conservative. Also assumed was a cost of \$98 per acre to plant the seedlings and a first-year herbaceous weed control treatment of \$54 per acre (Briggs 2007).

Due to limited pulpwood roundwood markets, the only product class was sawtimber (Future of Washington Forests, McIver et al., 2013; Simmons et al., 2014; Simmons et al., 2016). Stumpage values are an average from Washington DNR 2017 stumpage value determination tables for tax reporting purposes (http://dor.wa.gov/Docs/Pubs/ForestTax/fh2017/InstrSVtables2017_1stHalf.pdf) for the "Westside," a value of \$391 per MBF of Scribner log scale. Outputs from DFSIM were a minimum DBH of 7.6 inches up to a 6-inch top DIB for logs 32 feet in length (Curtis et al., 1982). Roughly equivalent to \$156 per cord for sawtimber, when assuming 2.5 cords per MBF.

RESULTS AND DISCUSSION

Loblolly pine produces substantially more merchantable (given current markets and assumptions) volume early in rotations (Figure 2) but is eventually exceeded by DF when using rotation ages of 34 and 56 years. RPP produces a fair amount of volume while ABg lags far behind, but regeneration costs for ABg are essentially null and hence this cover type still provides an attractive economic alternative. At the current time, on the Westside Cascades as well as the Inland Northwest, there is limited demand for smaller material Douglas-fir wood and hence only sawtimber yields are depicted. If the roundwood pulpwood market becomes stronger or if smaller material can be sold as biomass, then DF will likely become even more competitive. Plus, if smaller material becomes merchantable thinning may once again become economically attractive for DF.

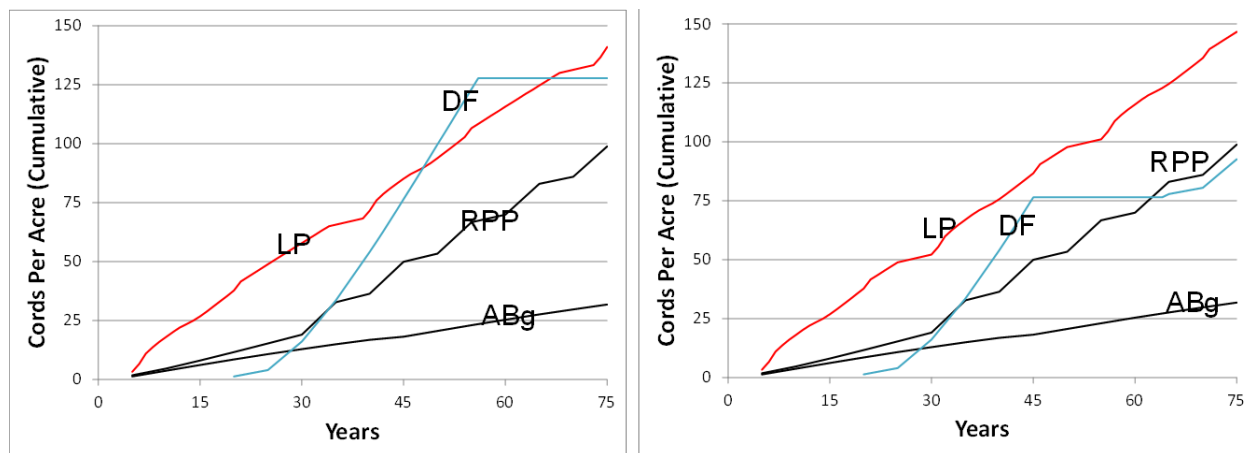


Figure 2. Projected cumulative yields by cover type when using an interest rate of 3% (left) and 6% (right). All cover types are on a 75-year projection period due to RPP, thus for instance LP's cumulative volume is based on roughly two 34-year rotations (left) and three 25-year rotations (right). LP – uses yields from Ptaeda 4.0 and consists of two thinnings at ages 12 and 20, and a final clearcut at age 34 (left) and at age 25 (right). DF – uses modified yields from DFSim and consists of a final clearcut at age 56 (left — trajectory only contains sawtimber and therefore from years 56 to 75 the trajectory is flat since predicted sawtimber production doesn't begin until age 20) and at age 45 (right - trajectory only contains sawtimber and therefore from years 45 to 64 the trajectory is flat since predicted sawtimber production doesn't begin until age 20), RPP – based on work from VanderSchaaf and Deckard (2012) and consists of thinnings at ages 25, 35, 45, 55, and 65 with a final clearcut at age 75 (left) and at age 65 (right – no thinning at age 65), ABg — uses modified yields from Walters and Ek (1993) and consists of a final clearcut at age 40 (both left and right).

When using a 3% interest rate, the optimum economic rotation age for LP, DF, RPP, and ABg were 34, 56, 75 (although RPP was essentially flat after age 65), and 40, respectively (Figure 3). For LP, this is relatively high given current sawtimber economic rotation ages in the region (e.g., 20 to 25), however, a low interest rate (3%) was used indicative of an alternative used for Minnesota DNR lands. When using a 6% interest rate, the economic rotation ages decrease to 25, 45, 65 (although essentially flat after age 55), and 40, for LP, DF, RPP, and ABg, respectively (Figure 3). With that said, LP was limited to a youngest age of 25 since thinnings were fixed at ages 12 and 20, and ABg was limited to age 40 because of likely “real world” operational and harvestable constraints. Alternative thinning regimes may result in lower economic rotation ages for LP (e.g., 20 years). For DF, the rotation age of 45 years associated with a 6% interest rate, as opposed to 56 years with a 3% interest rate, is more consistent with average rotation ages of around 47 years for Site Class II Douglas-fir plantations presented by Briggs (2007).

As interest rates increase, the time value of money becomes more meaningful reducing rotation ages. Since LP grows relatively faster than the other cover types, yet at around ages 35 and greater LP growth rates start to substantially decrease, allowing DF to eventually surpass LP cumulative harvested volumes, as interest rates become greater LP becomes the most economically attractive. At an interest rate of 3% (resulting in an LP rotation age of 34 years), DF actually produces a greater economic return over infinite rotation ages (Figure 3). However, at a 6% interest rate, LP is the most economically attractive.

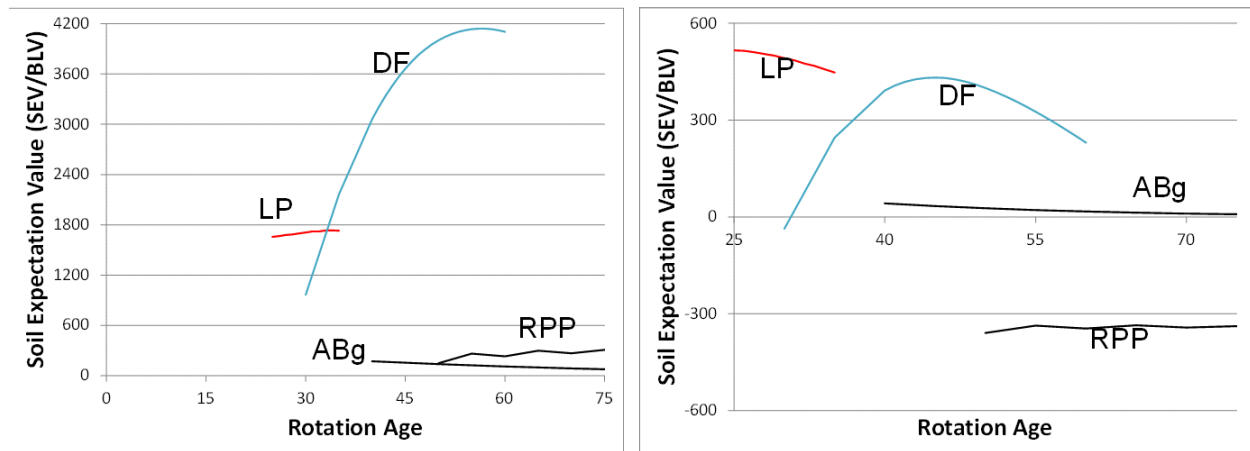


Figure 3. Projected Soil Expectation Value (SEV) by cover type when using an interest rate of 3% (left) and 6% (right). 2015 stumpage prices for ABg and RPP, and 2016 and 2017 stumpage prices for LP and DF, respectively. LP – uses yields from Ptaeda 4.0 and consists of two thinnings at ages 12 and 20. DF – uses modified yields from DFSim, RPP – based on work from VanderSchaaf and Deckard (2012) and consists of thinnings at ages 25, 35, 45, 55, and 65, ABg – uses modified yields from Walters and Ek (1993).

When interest rates are near 3%, LP produces greater economic returns than ABg and RPP because of greater yields and faster growth rates. For pulpwood, on a cord basis, aspen exceeds loblolly pine stumpage prices (\$36 per cord versus \$26 per cord – Figure 4), however, the ABg cover type is often comprised of other, lower value pulpwood material of other species as well, which makes the revenues likely more equivalent. DF is the most economically attractive because of good growth rates after age 20 or so, plus stumpage values that have remained exceedingly high compared to the Lake States and the southern US. ABg has low regeneration costs, but does not have the growth rates of LP and DF, and certainly cannot demand the revenues that DF stumpage demands. RPP has good growth rates after age 30 or so but it also cannot, given current markets, demand the stumpage values of DF. Currently, sawtimber stumpage values are around \$156, \$62, and \$89 per cord, respectively, for Douglas-fir, loblolly pine, and red pine. Although LP has relatively low sawtimber values, its revenues come much earlier in the rotation therefore reducing the impacts of discounting.

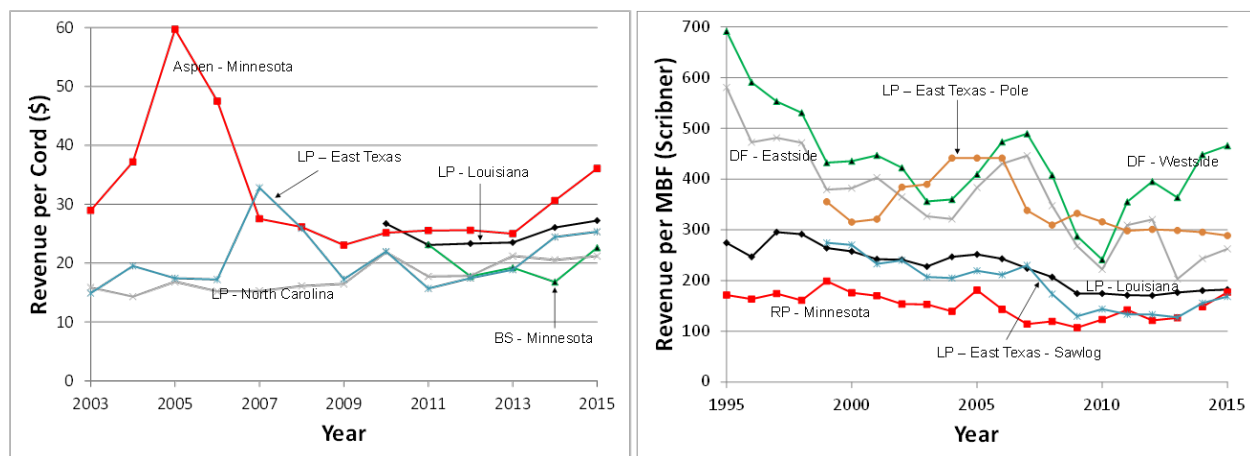


Figure 4. Pulpwood revenues (left) for loblolly pine in East Texas, North Carolina, and Louisiana, and aspen and black spruce in Minnesota. Sawtimber revenues (right - all values converted to Scribner based on local conversions)

for Douglas-fir on both the Eastside and Westside of the Cascades, loblolly pine in East Texas and Louisiana, and red pine in Minnesota. For East Texas, both sawlog and pole prices are shown.

When interest rates are near 6%, LP produces greater economic returns than ABg and RPP because of greater yields and faster growth rates, and LP even exceeds DF because of the time value of money. DF is still relatively economically attractive because of good growth rates after age 20 or so, plus stumpage values that have remained exceedingly high compared to the Lake States and the southern U.S. ABg has low regeneration costs compared to RPP and hence ABg's return remains positive. At a 6% interest rate, based solely on projected economic returns and current market conditions, establishing RPP appears to result in revenue losses. This is why some landowners are seeding their regenerated RPP stands as opposed to planting.

Interestingly, because of low or null regeneration costs, as interest rates get beyond around 12%, ABg becomes the most attractive. For a rotation age of 40 years, ABg Internal Rate of Return (IRR) is actually 33%. The three other cover types have high initial investment costs, and for interest rates above 12% (DF around 7.5% and RPP around 3.8%) it would be best to invest in another alternative. For rotation ages of 25, 45, and 65 (based on the 6% interest rate), the IRR for LP, DF, and RPP are 12.0%, 7.5%, and 3.85%, respectively. In addition, risk and uncertainty are also not addressed, ABg has relatively low financial risk compared to the other cover types. As mentioned earlier, several agencies want to convert their ABg stands to other cover types, economically speaking, given current market conditions at least and based on projections, this may not be an economically attractive alternative.

These analyses ignored utility poles, stumpage rates generally greatly exceed even sawtimber rates. Red pine, Douglas-fir, and loblolly pine all are utilized as utility poles. Douglas-fir and red pine are also used as cabin/house logs — this is not common for loblolly pine.

LITERATURE CITED

- Barlow, R, and W. Levendis. 2015. 2014 Cost and cost trends for forestry practices in the South. *For. Landowner* September/October: 23-31.
- Briggs, D. 2007. Management practices on Pacific Northwest West-side Industrial Forest Lands, 1991-2005: With Projections to 2010. Stand Management Cooperative, College of Forest Resources, University of Washington. Seattle, WA. 79 p. http://www.cfr.washington.edu/research.smc/working_papers/smc_working_paper_6.pdf
- Curtis, R.O., G.W. Clendenen, D.L. ReU.K.ema, and D.J. DeMars. 1982. Yield tables for managed stands of coast Douglas-fir. Gen. Tech. Rep. PNW-135. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 182 p.
- Dickens, E.D., D.J. Moorhead, and B. McElvany. 2003. Pine plantation fertilization. *Better Crops* 87: 12-15.
- McIver, C.P., C.B. Sorenson, C.E. Keegan, T.A. Morgan, and J. Menlove. 2013. Montana's forest products industry and timber harvest, 2009. Resour. Bull. RMRS-RB-16. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 42 p.
- Marshall, D.D., and E.C. Turnblom. 2005. Wood productivity of Pacific Northwest Douglas-fir: estimates from growth-and-yield models. *J. For.* 103: 71-72.
- Miller, A. 2017. Forest investing: time is money. *For. Landowner* May/June: 22-27.
- Piva, R.J., J.W. Bentley, and S.W. Hayes. 2014. National Pulpwood Production, 2010. Resource Bull. NRS-89. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Southern Research Station. 74 p.
- Simmons, E.A., S.W. Hayes, T.A. Morgan, C.E. Keegan, III, and C. Witt. 2014. Idaho's forest products industry and timber harvest 2011 with Trends Through 2013. Resour. Bull. RMRS-RB-19. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 46 p.
- Simmons, E.A., M.G. Scudder, T.A. Morgan, E.C. Berg, and G.A. Christensen. 2016. Oregon's forest products industry and timber harvest 2013 with trends through 2014. Gen. Tech. Rep. PNW-GTR-942. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 58 p.
- Talbert, C, and D. Marshall. 2005. Plantation productivity in the Douglas-fir region under intensive silvicultural practices: results from research and operations. *J. For.* 103: 65-70.
- VanderSchaaf, C.L., and D. Deckard. 2012. Estimating yields of red pine plantations for Minnesota DNR Subsection Forest Resource Management Plans (SFRMPs). Minnesota Department of Natural Resources. St Paul, MN. 17 p.
- Walters, D.K., and A.R. Ek. 1993. Whole stand yield and density equations for fourteen forest types in Minnesota. *North. J. Appl. For.* 10: 75-85.
- Wilent, S. 2014. Forest Products in 2014: Prospects good, but look for price volatility. *The Forestry Source* 19: 1, 3.

Concurrent Session 3B Economic Impact Analysis

SINGLE AND MULTIPLE INDUSTRY ECONOMIC CONTRIBUTION ANALYSIS USING IMPLAN

James Henderson¹

Abstract—Industry economic contribution analysis is used to estimate the contribution of a sector or group of sectors to an entire economy. The methodology presented here describes a technique that accounts for input bias that results when modeling output as a final demand. This type of bias can be corrected by adjusting the direct effect to account for indirect and induced effects a sector can have upon itself and other sectors of interest. This method uses model multipliers to account for this input bias by reducing the direct effect and is described for conducting both single and multiple industry economic contribution analyses.

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INCORPORATING AMERICAN COMMUNITY SURVEY FINDINGS INTO A NORTH CAROLINA SOCIAL ACCOUNTING MATRIX PROVIDES HOUSEHOLD INCOME CLASS MULTIPLIERS

Adam Scouse, T. Eric McConnell, Stephen Kelly, and Richard Venditti¹

Abstract —Additional analysis is required to accurately determine an industry's economic impacts to households. This is because the earnings for all industries in a conventional social accounting matrix (SAM) are pooled and then distributed to a region's household income classes via a single, fixed-share payment. Earnings distributions to low, middle, and high income classes often differ significantly, though, between industries. One avenue for augmenting traditional SAM modeling techniques is via Public Use Microdata Samples (PUMS) from the U.S. Census Bureau's American Community Survey. We integrated findings from the PUMS dataset for North Carolina into a state SAM and determined how these earnings create larger economic multipliers. Earnings varied from \$262 million to \$1,525 million for Forestry and Logging, Support Services, and Wood Products, Paper, and Furniture Manufacturing. Household multipliers were 0.633 for Forestry and Logging; 0.888 for Support Services; 0.449 for Wood Products; 0.337 for Paper; and 0.447 for Furniture. Mid-income households displayed higher multipliers in Forestry and Logging (0.383), Support Services (0.507), and Furniture (0.202). The multiplier effect for high income households was highest in Wood Products (0.209) and Paper Manufacturing (0.174). Low income households had the overall lowest multipliers, but Support Services displayed a much higher multiplier in this class (0.151) compared to other industries. PUMS data sets can be used to describe how an industry's earnings are distributed to households with different income levels, recognizing that these distributions vary from industry to industry, and that multiple individuals can contribute to a single household.

Keywords: Forest Products Industry; Households; Industry Earnings; Industry Output; Social Accounting

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IDENTIFYING UNITED STATES FOREST SECTOR SUPPLY CHAINS VIA AN INPUT-OUTPUT ANALYSIS

T. Eric McConnell¹

Abstract—To gain a better understanding of the forest product supply chain network, the number of supply chains present within the United States forest economy was estimated using qualitative input-output analysis. Industry economic input-output accounts were obtained from the Bureau of Economic Analysis and consolidated to 71 industries. The use matrix was purged of imports, which facilitated studying supply chains contained solely within the U.S., and column-normalized to reflect industry direct requirements. Cells greater than or equal to \$0.014 were re-coded as “1,” otherwise “0” (where $0.014 = 1/71$). This revealed direct forest sector purchases of measurable size, with efforts focused on the four forest-based sectors of Forestry and Logging along with Wood Products, Paper, and Furniture Manufacturing. Sequentially raising this new binary matrix to higher powers quantified the number of indirect connections between a forest sector and its upstream suppliers. The forest industries possessed a total of 225 direct links. In all, 1,640 supply chains of three or fewer links were discovered. Forestry and Logging contained fewer supply chains at each measured length because of its upstream location in the forest value chain. Furniture manufacturing possessed the greater number of supply chains at each length due to its nature as a secondary processing sector. This is a first step to characterizing the structural paths taken by forest sector multiplier effects as they ripple through the economy. Potential bottlenecks inhibiting growth can be identified as well as targeting where economic assistance efforts may be required in the case of industry contraction.

Keywords: Forestry and Logging; Input-output model; Paper Manufacturing; Wood Furniture Manufacturing; Wood Products Manufacturing

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Concurrent Session 3C Parks and Recreation

A TRAVEL COST APPROACH TO VALUE NON-MOTORIZED RECREATION ON WILD AND SCENIC RIVERS IN THE U.S. NATIONAL FORESTS

Binod P. Chapagain, Neelam C. Poudyal, J. M. Bowker, Don English, Ashley Askew, and Don Hodge¹

Abstract—The Wild and Scenic Rivers Act of 1968 has designated the rivers or sections of rivers with outstanding values to ensure free-flowing conditions of the rivers by prohibiting the construction of dams or other instream structures that would harm the free-flowing condition, water quality, or resource values. More than 12,709 miles of 208 rivers have been designated as Wild and Scenic Rivers and majority of them are managed by the U.S. Forest Service. About 1.64 million recreationists annually visit in both designated and non-designated rivers in the National Forests for non-motorized water travel activities including rafting, sailing, canoeing, and boating. Despite its popularity, literature on economic valuation of non-motorized water activities, especially to designated rivers, is relatively scant. This study is timely, especially considering the fact that the Wild and Scenic River Act is observing its 50th anniversary in 2018 and therefore, there is an increasing interest among stakeholders in understanding accomplishments and net benefits of this law.

In an effort to fill this gap in knowledge, this study employed an individual travel cost model to trip data collected from on-site survey of recreationists in National Forest System. In particular, count data models were fitted into trip data from 3,917 visitors surveyed from 2005-2014 as part of NVUM survey and per trip consumer surplus associated with designated and non-designated rivers were estimated. Results indicate the net benefit of access to recreation on those sites is significant. Findings will broadly inform recreation planners, managers, and policy makers in understanding the economic significance and public value of non-motorized recreation resources in designated and non-designated rivers nationwide.

Keywords: Wild and Scenic Rivers, National Forests, Travel Cost Method, Forest Service

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VISITOR SPENDING PATTERNS AT THE BUFFALO NATIONAL RIVER

Sayeed R. Mehmood¹

Abstract —The Buffalo National River (BNR), America's first designated national river, was created in March of 1972 by an act of Congress. Administratively, it is part of the national park system and includes a 135-mile stretch of the Buffalo River. Visitor use of the BNR has grown steadily over the last few decades. While a significant number of these visitors are from within the state, the BNR has always received high numbers of out-of-state visitors. For this study, visitor spending data collected from the concessionaires servicing the BNR were used. Additionally, based on visitor zip code, certain secondary socioeconomic data were used. A statistical model was then estimated to identify the significant factors influencing visitor spending at the BNR. Results indicate that significant factors influencing visitor spending were distance traveled, number of people in the party, use of guides, rental of canoes and other equipment, region of visitor origin, and median household income.

Keywords: Recreation demand; visitor spending.

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UNDERSTANDING LANDOWNERS' INTEREST AND WILLINGNESS TO PARTICIPATE IN FOREST CERTIFICATION PROGRAMS IN CHINA

Nana Tian, Neelam C. Poudal, Fadian Lu, Donald G. Hodges, and Timothy M. Young¹

Abstract—Forest certification is considered a viable market-based strategy to promote sustainable forest management as it provides financial incentives and social recognition for responsible forest practices. Certification and sustainability of forests in China is an issue of international concern, especially considering the extent of China's wood product export to other regions including North America and Europe. However, the success of such programs may depend on opportunities and challenges faced by forest landowners. To examine landowners' perceived barriers and interests in forest certification in China, this study conducted a household survey in Shandong province in 2016. Data analysis involved modeling whether and how ownership motivations, management objectives, ownership structures, socio-demographic characteristics, and other factors defending certification schemes influence landowners' willingness to participate in certification programs. Results indicate that the majority of landowners in Shandong province are not currently familiar with forest certification programs but are willing to consider it when provided with pertaining information (i.e., potential cost, benefits). Result suggests that there may be a potential market for certification program in China with appropriate outreach and extension. In addition, results from an ordered logit regression showed that landowners' willingness to participate in forest certification was significantly related with perceived benefits and limitation associated with certification schemes, landownership motivation and management objectives, and characteristics of the forestland as well as the household. Findings will be useful to institutions and policy makers interested in understanding and promoting market for forest certification in China and other developing countries with similar socioeconomic and forest resource characteristics.

Keywords: Forest certification; Ordinal logit regression; Forest landowners

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Featured Presentation

EXPLORING BIODIVERSITY- PRODUCTIVITY RELATIONSHIP USING GLOBAL FOREST BIODIVERSITY (GFB) DATA

Jingjing Liang¹

Abstract—We consolidated field-based forest inventory data from 777,126 permanent plots across the world, and discovered a globally consistent positive effect of tree species diversity on forest productivity, whereby a continued biodiversity loss would result in an accelerating decline in forest productivity worldwide. We further estimated that the economic value of biodiversity in maintaining commercial forest productivity alone to be USD\$396–579 billion per year, which is over five times greater than the total cost of effective global conservation. This finding highlights the need for a worldwide re-assessment of biodiversity values, forest management strategies, and conservation priorities.

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Concurrent Session 4A

Stated Preference

COMPARING ATTITUDES AND PERCEPTIONS OF FOREST CERTIFICATION AMONG FORESTERS, LOGGERS, AND LANDOWNERS IN MISSISSIPPI

John B. Auel, Stephen C. Grado, Jason S. Gordon, James E. Henderson, and Thomas A. Monaghan¹

Abstract—Forest certification plays an important role in the forest products industry in Mississippi. Approximately 17% of the state's 19 million acres of forest land is certified under one of three major systems in the United States. More than two million acres are certified under Sustainable Forestry Initiative, more than one million acres are certified under American Tree Farm System, and over 150,000 acres are certified under Forest Stewardship Council.

The three groups generally agreed on most aspects of forest certification. There were some significant differences between the groups based on the distribution of responses, but the scale averages never differed by more than 0.7 indicating that while the differences were significant. Overall they were still fairly close in their understanding of certification concepts.

There was a large number of non-industrial private landowners who were not aware of forest certification. This result has not changed since the last landowner study that was conducted in Mississippi regarding forest certification, almost 10 years ago.

INTRODUCTION

The Report of the World Commission on Environment and Development: Our Common Future, more often referred to as the Brundtland Report (United Nations 1987), outlined global environmental concerns. It also proposed strategies for development and use of resources that would change the way the world forestry community would grow, harvest, and utilize trees for products necessary for society. The report initially established the working definition of sustainability; "to meet the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, 1987). This definition is the basis for each of the forest certification systems currently used across the globe. It also strongly implies that sustainable development, as outlined in the report, is the only way to ensure adequate resources for future generations, thus creating a case for the existence of a recognizable societal benefit from how forests, and the environment in general, are managed.

Sustainability as defined by the Brundtland Report, and incorporated into forest certification programs, is crucial to forestry and forest industry. While less than 10% of the world's forests are actually certified, these forests represent 25% of world-wide industrial production (Moore and others, 2012). North America boasts 450 million forested acres certified under one of three major systems, Forest Stewardship Council (FSC), Sustainable Forestry Initiative (SFI),

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and American Tree Farm System (ATFS) (ATFS 2014, FSC 2014, SFI 2014). Considering that the advent of modern third party verified forest certification was less than 25 years ago, this is an impressive accomplishment.

Practitioners often assume that third-party verification, and/or sustainable forestry in general, is inherently important to society and the benefits obvious. The use of third-party verification adds credibility to certification programs through conformance audits (SFI 2015a). Auditors (i.e., employees and sub-contractors) who contract with independent certification bodies examine all aspects of the management of a particular forest to ensure practices are in line with the certification program standards. However, recent studies have shown less than 10% of all nonindustrial private forest (NIPF) landowners in the U.S. “have a management plan, participate in a cost share program, certify their forest land, or hold a conservation easement” (Ma and others, 2012a). This suggested that the social and environmental benefits of certification and/or sustainable forestry are either unknown to the NIPF landowner or are less important than other landownership goals. Ma and others (2012b) reported that most NIPF landowners in Minnesota were unaware of forest certification even though Minnesota has a robust forest industry, with over 7 million acres of public lands certified (MFI 2009). A similar study of NIPF landowners in Mississippi and Louisiana, both states with vibrant forest products industries, showed less than half of the respondents agreed with the statement “I understand the concepts of forest certification” (Perera and others 2007). If the majority of NIPF landowners in Minnesota, Mississippi, and Louisiana lack knowledge and understanding of the benefits of sustainable forestry and certification, then NIPF landowners across the United States may also lack this same understanding. Further, if private forest landowners lack an understanding of sustainable forestry and certification, the societal benefits of forest certification may be unknown to society on an even broader scale.

Perceptions of professional loggers regarding forest certification are rarely found in the literature. Training in sustainability goals is required under all three certification systems, so loggers are crucial to the process. However, a literature search covering the last 20 years failed to turn up any published studies for Mississippi. Each of the three certification systems has changed over that time as well. A study comparing attitudes of foresters, loggers, and landowners in Mississippi concerning current certification systems is long overdue.

LITERATURE REVIEW

Societal Benefits

Black’s Law Dictionary defines social benefit as “an increase in society’s welfare derived from a course of action that is not always quantifiable” (The Law Dictionary, 2015). This is especially true when making decisions that affect the environment. Society may benefit in two ways from environmental decisions. The first is an immediate benefit. In the case of forest industry, this includes economic and non-economic contributions in the form of jobs, forest products, recreation, clean water, and other goods and services (Maker and others, 2014). All of the immediate benefits are quantifiable to varying degrees. The second benefit, and one that is at the crux of the Brundtland Report and forest certification, is the future benefit realized from current actions. Forest industry is attempting to ensure, through certification of their practices, that future generations will realize the same, or enhanced, services from the forest enjoyed by present society (Butterfield and others, 2005). Although it is difficult to measure future unrealized benefits, the relative importance of those future benefits to today’s society can be quantified and used as a measure of societal benefits of certification that corresponds to the Brundtland Report goals.

Forest Certification and the Public

Forest certification has been suggested as the best approach to assuring the public that forests are being managed in an environmentally, economically, and socially sustainable manner (Chen and others, 2010), as verified through an independent third-party assessment (FSC, 2014). Each of these three broad areas contributes to the overall future societal benefit. While it is true that certification is not necessary to ensure sustainability of forest resources, the public is generally distrustful of forest products company and agency claims and have shown a preference for some type of certification, even though many were uncertain about the concept (Perera and others, 2007). For example,

NIPF landowners from Mississippi and Louisiana reported other types of forest landowners (i.e., industrial, state, federal) were in greater need of certification than themselves. The finding suggests a significant challenge to communicating the relevance of NIPF certification since there is an increasing reliance on NIPF landowners for supplies of forest products (Butterfield and others, 2005). An all-encompassing realization of societal benefits may be difficult without NIPF landowner participation in sustainable forestry.

Benefits of Certification

Associated benefits from certification are also well known for the company, agency, or landowner. Generally, direct benefits can be categorized under market access, public image, and potential for price premiums (Chen and others, 2010). However, as certified acreage continues to grow, certified material may be easier to obtain for the wood using firm, and improved market access for NIPFs may not be realized. Public image may be improved if more certified material is available in the marketplace, but the ability to realize a price premium may diminish with increased supplies. In one study it was stated that “The mass adoption of forest certification by the forest products industry in the U.S. has surpassed the creation of a niche market, in which exclusivity breeds premium prices by targeting the most environmentally conscious consumers” (Aguilar and Vlosky, 2007).

Indirect benefits of certification are based more on perception, both internal and external, and include improved forest management (Schreiber, 2012) when compared to practices that were in place prior to adopting a certification standard. Measuring indirect benefits, like improved forest management, becomes difficult when the definition of improved forest management changes with the individual certification scheme adopted by the landowner. For example, limitations on the size of forest openings following harvests are different for FSC (2010) and SFI (2015a); however, each are promoted as sustainable and attempting to fulfill that particular part of the indirect social benefit.

An emerging indirect benefit of certification is seen in the social license to operate by wood using industries. The public demands assurances that certain industry practices not only meet minimal regulatory criteria but that communities have some input into management decisions for forests in their area. Certification provides avenues for stakeholders to have input in management decisions and could potentially improve their opinion of wood using industries through involvement in the process. This participation in the process could maintain the social license to practice forestry for forest industry in areas where the community is most engaged in environmental issues (Moffat and others, 2015). This in turn, may reduce the perceived need by the community for additional regulation by local, state, and national governments.

Supply Chain and Sustainable Forestry

There are three groups heavily invested in forestry which need to work together to achieve sustainability goals for forest lands: the NIPF landowner, professional logger, and industrial forestry professional. Together these groups make up the primary components of the supply chain for forest products. This supply chain is only effective if each member has mutual respect for the others, an understanding of the forest management goals and a commitment to treat each other fairly (Taylor, 2012). The degree to which these groups agree on forest management goals is critical for ensuring a sustainable resource and non-monetary benefits to the public. Forest products companies that purchase stumpage work directly with landowners to achieve these goals. However, in Mississippi, 74% of professional loggers purchase 75% of their own stumpage (Taylor, 2009), bypassing management foresters in many cases. Decisions loggers make on the ground impact the resource and sustainability of that resource. Loggers who have the same understanding of sustainability goals will make informed decisions in the absence of professional forester oversight and the supply chain will remain effective in achieving these goals.

Forest Certification in Mississippi

Mississippi has over 19 million acres of forest land (Oswalt, 2013) with some 300,000 NIPF landowners (Gordon and others, 2013). Economic output from the forestry sector is in excess of \$10 billion (Henderson and Munn, 2013). Wildlife recreation in the state accounts for almost \$1 billion of expenditures by participants each year

(Poudel, 2014). Certification of forests plays an important role with over 3 million acres certified under one of the 3 major standards, ATFS, SFI, and FSC (ATFS, 2015; FSC, 2015; SFI, 2015b).

OBJECTIVES

This project identified and compared the perceptions of forestry and forest certification among three sample populations (i.e., forest landowners, Mississippi SFI Implementation Committee (SIC) members, and loggers who are members of the Mississippi Loggers Association (MLA)) in Mississippi using a multi-method survey approach. A survey was developed to test nine hypotheses related to forest management and certification (Table 1). Focus areas include attitudes regarding forested areas, benefits of forested areas, perceptions of a well-managed forest, importance of certification in general, understanding of SFI, FSC, and ATFS, purchasing decisions, and finally, public involvement in forest management decisions. This paper concentrates on awareness of certification, awareness of certification programs, and perceptions of certification.

METHODS

Likert Scales and Likert Items

Rensis Likert pioneered attitudinal survey research by developing a scale based on the responses to a group of individual items, referred to as Likert Scales and Likert Items, respectively (Sullivan and Artino, 2013). Individual items are rated on an ordinal set of responses. A typical Likert Item utilizes a set of five responses; “strongly disagree,” “disagree,” “neither agree nor disagree,” “agree,” and “strongly agree.” The responses were coded one through five for the analysis in this study. The idea behind the set of responses was to categorize an underlying continuous distribution of possible responses. When grouped together to form a scale of Like Items, responses were summed and analyzed using parametric statistics (Sullivan and Artino, 2013).

Survey Instrument

The survey instrument was developed in Qualtrics, an on-line survey program available for use by university researchers, and was identical for each of the three groups. The survey consisted of 14 sections which required 10 to 15 minutes to complete.

The first two scales were designed to test the general attitudes of respondents regarding forested areas (Section I) and benefits derived from those areas (Section II). The individual items that make up each scale were chosen based on the qualities and benefits defined in each of the three certification programs as core principles or standards (FSC, 2010; ATFS, 2014; SFI, 2015a). The standards and principles within each of the certification systems overlap to some degree. Aesthetics, for example, may be assessed under more than one principle in a single certification program.

Section I

Section I assessed general attitudes about forests using a seven item Likert Scale. Sustainability was introduced here in two ways. The first was whether they want their descendants to enjoy the same benefits of forests that they themselves do. They were then asked their opinions about managing sustainably. These questions gave an indication of the overall importance each respondent places on forests as well as general attitudes of each group based on composite scores.

Section II

This seven item Likert Scale assessed attitudes about specific benefits of forests, such as clean air and water and the economic contribution to the state. An additional response option of “don’t know” was coded as six. The difference between “neither agree nor disagree” and “don’t know” was assumed to be the respondent’s understanding of the concept presented in the item. “Don’t know” meant the respondent did not understand the concept whereas “neither

agree nor disagree” indicated the respondent understood the concept but did not think it affected the issue identified in the item. For example, a respondent who answered, “don’t know” to Item 4, Forests are important for sequestering carbon, was unsure if forests provided this service. A respondent who answered, “neither agree nor disagree” understood that forests store carbon, but was unsure of the relative importance.

Section III

This was a 13-item Likert Scale used to assess the extent that the groups agree to certain aspects of a “well-managed” forest. If the respondents felt forests were important and contributed to environmental services, then for a forest to be well-managed, environmental services were enhanced by virtue of management. Again, the “don’t know” category was added to potential responses.

Section IV

This was a “yes” or “no” question to determine the proportion of each population that had heard of forest certification. Skip logic was used so if a respondent answered no, they were asked to skip the four sections that deal with specific certification issues and move to Section IX, which deals with purchasing preferences for certified wood products.

Section V

This was a five-item Likert Scale about certified forests and their feelings about whether certified forests are well-managed and whether forests should be certified. Only respondents who had heard of certification should have answered this scale.

Section VI

This section dealt with SFI. The first question was whether or not a respondent was aware of SFI. If they had not heard of it, then they were instructed to skip to Section VII, an identical scale about FSC. Only those who had heard of certification in Section IV should have arrived at this Section. The second part of the Section was an eight item Likert Scale specific to SFI. Respondents were asked if they understood the goals first, followed by six items common to all three certification schemes, and finally, whether or not SFI certification made timber more valuable.

Section VII

This Section dealt with FSC. The first question was whether or not a respondent had heard of FSC. If they had not, then they were instructed to skip to Section VIII, an identical scale about ATFS. Only those who had heard of certification in Section IV should have arrived at this Section. The second part of the Section was an eight item Likert Scale specific to FSC. Respondents were asked if they understood the goals first, followed by six items common to all three certification schemes, and finally, whether or not FSC certification made timber more valuable.

Section VIII

This Section dealt with ATFS. The first question was whether or not a respondent had heard of ATFS. If they had not, then they were instructed to skip to Section IX, which dealt with purchasing preferences for certified wood products. Only those who had heard of certification in Section IV should have arrived at this section. The second part of the Section was an eight item Likert Scale specific to ATFS. Respondents were asked if they understood the goals first, followed by six items common to all three certification schemes, and finally, whether or not ATFS certification made timber more valuable.

Section IX

Section IX dealt with purchasing preferences and decisions for certified forest products. The distinction is made between products from well-managed vs products from certified sources. Whether or not a respondent looked for a certification label and whether price was more important than certification or if certification was more important than price. Additionally respondents were asked to agree or disagree with whether buying certified products protected the environment and ensured sustainability.

Sections X through XIII

These sections were identical assessments except for the type of forest referenced. The intent was to gauge each group's attitudes about whether the general public expects various forest ownerships to be certified or well-managed and to what extent the public should be involved in management decisions. The different forest types were federal, state, industry and private forest lands.

Section XIV

Section XIV asked each respondent to complete a socio-demographic profile. This profile included year of birth, gender, race, occupation and household income. Additional questions about types of land owned and whether or not the land was certified were included.

SURVEY GROUPS

On-line survey of state SFI members

The first study group was comprised of 53 SFI certified forest landowners, SFI certified chain-of-custody forest products mills, state government representatives, and forestry-related state association representatives. Together this group makes up the Mississippi Sustainable Forestry Initiative Implementation Committee (SIC). Several members represent companies that are also certified under FSC chain-of-custody. One company has a division that manages a group certificate of FSC certified lands in the South, although none of those properties are in Mississippi. State government representatives have land certified under the ATFS standard. All three certification schemes were represented in the sample. The survey was administered electronically with a link to a Qualtrics survey embedded in an e-mail. The survey link was sent to potential participants on September 17, 2015. E-mail reminders were sent after three weeks. An e-mail thanking the committee members for participation was sent two weeks after the reminder. The survey was closed on November 30, 2015.

Intercept survey of Mississippi Loggers Association members

Timber harvesting is a crucial aspect of sustainability; therefore, the second group consisted of members of the state loggers' association, the Mississippi Loggers Association (MLA). Group members were required to attend training programs for qualification to deliver to SFI certified mills and contract with SFI certified landowners. They maintain their qualification by earning continuing education credits on a two-year cycle. They have invested time and resources into their qualifications. The total membership of the association is 600 logging firms that are based and work primarily in Mississippi. The association has five monthly meetings with an average attendance of 55 individual loggers. A paper copy of the Qualtrics survey was administered in person to loggers attending five different MLA meetings. The first meeting was September 22, 2015 in Enterprise, Mississippi. Additional meetings were held October 1, 2015 in Sherman, Mississippi, October 10, 2015 in Brookhaven, Mississippi, October 12, 2015 in 4 Corners, Mississippi, and October 23, 2015 in Hattiesburg, Mississippi.

Mail survey of forest landowners

The third group consisted of Mississippi NIPF landowners. Some landowners have property under ATFS certification, while others do not. Landownership sizes vary. To capture landowners active in forest management, the minimum parcel size included in the sample was 100 acres, so forest management would more likely to be captured. Therefore, the survey was mailed to a random sample of Mississippi landowners with at least 100 acres of forest land using a property tax database available for use by Mississippi State University. The initial list contained 22,871 names. Each name was assigned a random number. The random numbers were sorted and the first 3,000 were selected to receive the survey. The selection process resulted in landowners in each of Mississippi's 82 counties represented in the sample. Surveys were mailed the second week of October 2015. A postcard "thank you and reminder" was mailed the last week of November 2015. The survey was closed on December 12, 2015. If an assumed 15% response rate was realized, it would yield 450 completed surveys. This was more than the required 381 completed surveys (Dillman and others 2009) for a population size between 20,000 and 40,000 individuals to

ensure statistical rigor. Surveys received after December 12, 2015 were not included in the analysis, although there were only a few falling into that category.

Analysis

All survey data were coded and entered into SPSS v 23 for analysis. Responses for each of the Likert Scales used in this survey were summed by group and t-tests were used to test for differences between group means. There are three possible pairings of data that were used in the tests: SIC v MLA, SIC v Landowner, and MLA v Landowner. One-way analysis of variance (ANOVA) could have been used, but this test just determines if there are differences among the three groups (UCLA 2016). T-tests would still have to be performed to determine the differences between each group, so this step was omitted since there were only three pairings.

Likert Scale responses that were significantly different between groups ($\alpha = 0.05$) were tested with non-parametric analysis to determine which Likert Items were the source of variation in the responses. The non-parametric test used was the Mann-Whitney U Test for differences in the distribution of ordinal responses (UCLA, 2016). Significant differences between groups ($\alpha = 0.05$) indicated that the distribution of responses was different for each group. Distribution graphs of responses were used to illustrate the trend for groups that showed significant differences.

The socio-demographic data collected as part of this survey was used to describe members of each group. Data such as age, gender, race, occupation, and household income were compiled, and frequencies, percentages or averages were reported where appropriate. Age was grouped into two different categories, ≤ 50 yrs old and > 50 yrs old, and used to test differences between age groups. T-tests were used to identify significant differences between the age groups on the summed responses to Likert Scales. Age group was then used as dependent variable in a logistic regression (UCLA 2016) to determine the effect of Item responses in predicting the age group of individual respondents.

RESULTS

Response Rates

All 53 SIC survey emails were delivered to the intended recipients. There were no non-deliverables. The overall response for the SIC was 40. However, three respondents opened but did not complete the survey. The total responses were 37 for a response rate of 69.8%. The MLA had a total attendance at all five meetings of 222. Of those attendees, 146 completed the survey for a response rate of 65.8%. Of the 3,000 Landowner surveys mailed, 169 were returned as undeliverable, eight landowners had died, four requested removal from the landowner list for unspecified reasons, and four had sold their land since the list was developed. This left 2,815 possible respondents to the initial survey. As of December 12, 2015, 526 completed surveys had been returned and entered into Qualtrics. The total response rate for Landowners was 18.7%.

Socio-demographic Information

Each respondent was asked to provide socio-demographic information such as race, birth year, occupation, household income, type of land owned, and whether or not that land was certified under one of the three certification systems that were part of the study. The SIC and MLA groups were roughly equal in age at 50.1 and 50.7 years, respectively, while Landowners were on average 17 years older. The majority of respondents from each group were male. The SIC had 31 males respond out of 34, the MLA 110 males out of 141, and Landowners, 415 males out of 518.

The typical SIC respondent was a 50-year-old white male landowner with a household income between \$100,001 and \$125,000. The typical MLA respondent was a 51-year-old white male landowner with a household income between \$50,001 and \$75,000. The typical landowner respondent was a 68-year-old white male with a household income over \$150,000.

Awareness of Certification

Responses to this question was a simple yes/no in Section IV of the survey. The largest disparity was in the Landowner group which was expected (Table 2). All respondents from the SIC group were familiar with forest certification. Almost 90% of MLA members surveyed were familiar with forest certification. Less than half of Landowners in Mississippi were aware of forest certification.

Respondents who indicated they were aware of forest certification were then asked about individual certification programs to gain an understanding of the relative knowledge of each of the three main programs in Mississippi, SFI, FSC, and American Tree Farm System. The results are in Table 3.

Attitudinal Scale Responses

Responses for each Likert Item were summed for each group, and then the average response for each scale was calculated. Averages of 1.0 to 2.9 indicate “disagreement” with the concept, averages of 3.0 to 3.9 indicate groups “neither agree nor disagree” (hereafter neutral), and averages over 3.9 tend to indicate “agreement.” Averages for each group show similarities across the board (Table 4). Each group tends to agree with the concepts in Sections I, attitudes regarding forested areas and II, specific benefits provided by forests, and are neutral with concepts presented in Sections III, perceptions of a well-managed forest and V, understanding of certified forests. The SIC tends to agree with the concepts of SFI (Section VI) where the MLA and Landowners are neutral. All three groups are neutral with the concepts of FSC, Section VII. In Section VIII, or ATFS, the SIC tended to agree more than the MLA and Landowners. When asked about purchasing decisions, the average responses for Section IX were again neutral. The same can be said of the next two Sections, X and XI about public involvement in federal and state owned forest management decisions. The last two Sections, XII and XIII, show disagreement with public involvement in forest management decisions on industrial lands by the SIC and all groups disagreeing with public involvement in forest management decisions on private lands.

Understanding of Certified Forests – Survey Section V

This scale was a five item Likert Scale designed to test the attitudes of each group regarding the importance of forest certification. The underlying concept was that certified forests are important to ensuring well-managed resources. Only those respondents who were aware of certification should have responded to this scale. The items in this scale were as follows: 1, Certified forests are well-managed, 2, Non-certified forests are not well-managed, 3, A major goal of forest certification is sustainable forest management, 4, I trust forest certification programs, and 5, Forests should be certified.

The difference in the means of the scale sums between groups will be in the difference in the distribution of responses to Item 4, or trust in forest certification programs. The SIC will trust the programs more than the MLA and the MLA more than the landowners.

H3: SIC > MLA > Landowners

H0: SIC = MLA = Landowners

T-tests were performed between the SIC ($\bar{x} = 17.1$, $n = 35$) and MLA ($\bar{x} = 16.7$, $n = 125$), the SIC and Landowners ($\bar{x} = 16.3$, $n = 291$), and the MLA and Landowners to determine whether any differences were significant ($\alpha = 0.05$). The only significant difference among the groups was between SIC and Landowners ($p\text{-value} = 0.030$, $\alpha = 0.05$). SIC and MLA had similar responses as did the MLA and Landowners. Differences between SIC and the Landowner group responses were tested using the Mann-Whitney U Statistic for differences in the distribution of ordinal responses in individual Likert items.

Four items in Section V showed significant differences in the distribution of responses between the SIC and Landowners. There was a difference for Item 1, certified forests are well managed ($p\text{-value} = 0.044$, $\alpha = 0.05$); Item 2, whether non-certified forests are well managed ($p\text{-value} = .0001$, $\alpha = 0.05$); Item 3, a major goal of forest

certification is sustainable forest management (p-value = 0.000, $\alpha = 0.05$); and Item 4, trust in certification programs (p-value = 0.042, $\alpha = 0.05$).

The distribution of responses to Item 1, certified forests are well-managed, showed that both are similar, but that the SIC ($\bar{x} = 4$, $n = 35$) had a higher percentage in the “strongly disagree” category, while Landowners ($\bar{x} = 4$, $n = 285$) had higher percentages in the neutral (neither agree nor disagree) and “disagree” categories (Figure 1).

The distribution of responses to Item 2, non-certified forests are not well-managed, showed a definite tendency to disagree by the SIC ($\bar{x} = 2$, $n = 35$). Landowners ($\bar{x} = 3$, $n = 287$) again were similar, but a higher percentage of respondents agreed to this statement or strongly agreed (Figure 2).

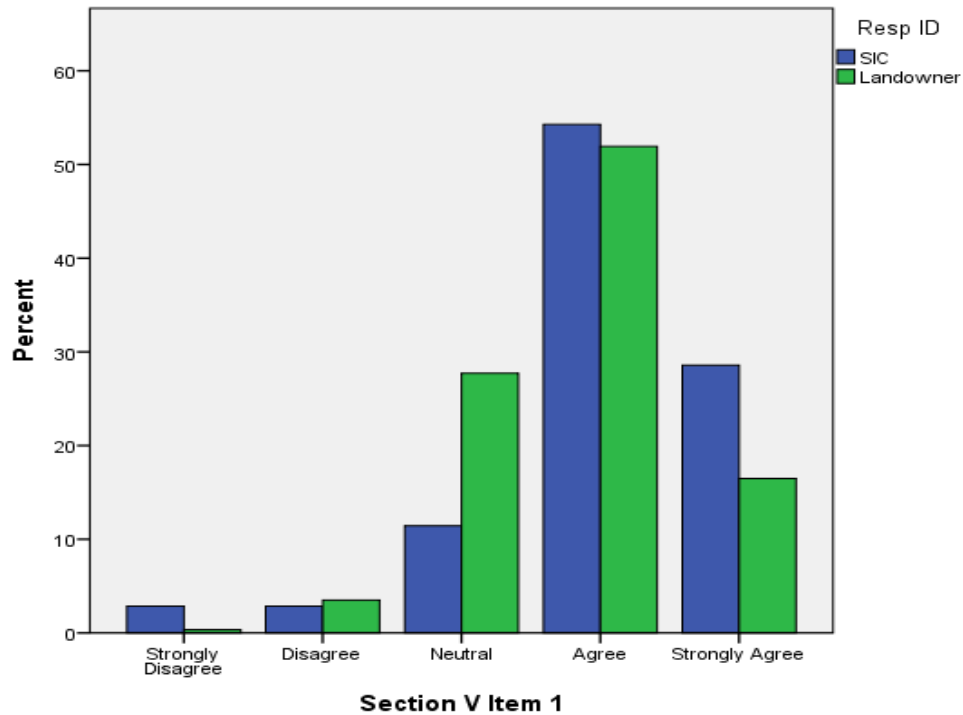


Figure 1: Distribution of responses for item 1, certified forests are well-managed forests. SIC – Members of the Mississippi SFI Implementation Committee

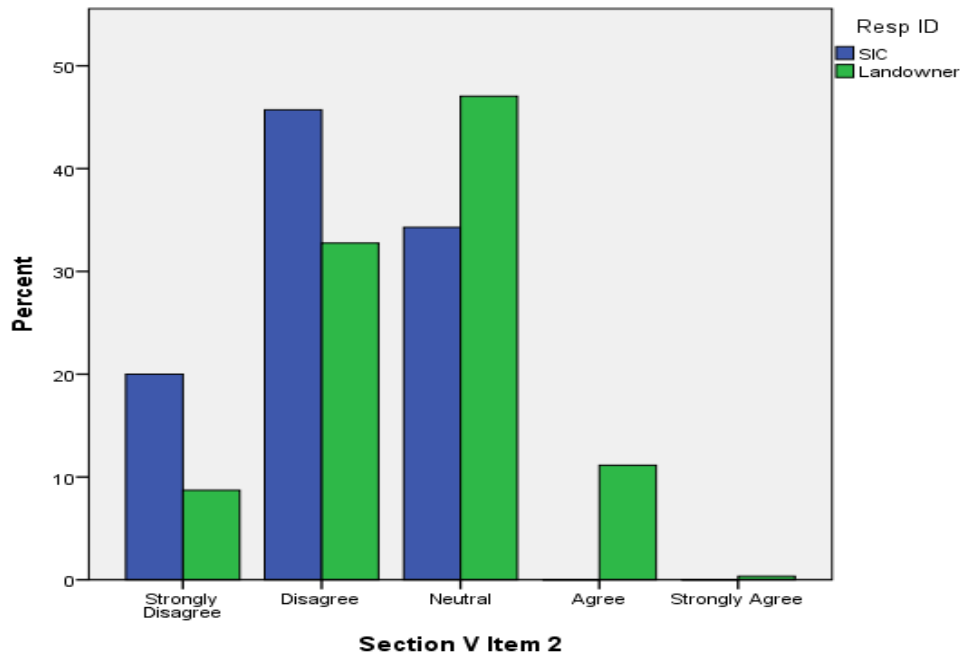


Figure 2: Distribution of responses to item 2, non-certified forests are not well-managed. SIC – Members of the Mississippi SFI Implementation Committee

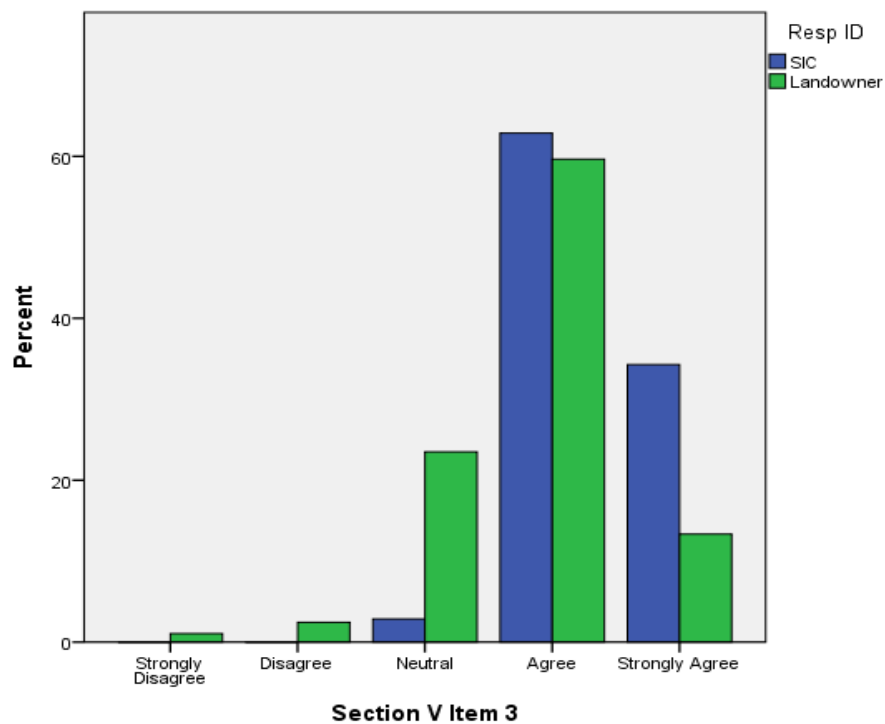


Figure 3: Distribution of responses to item 3, a major goal of forest certification is sustainable forest management. SIC – Members of the Mississippi SFI Implementation Committee

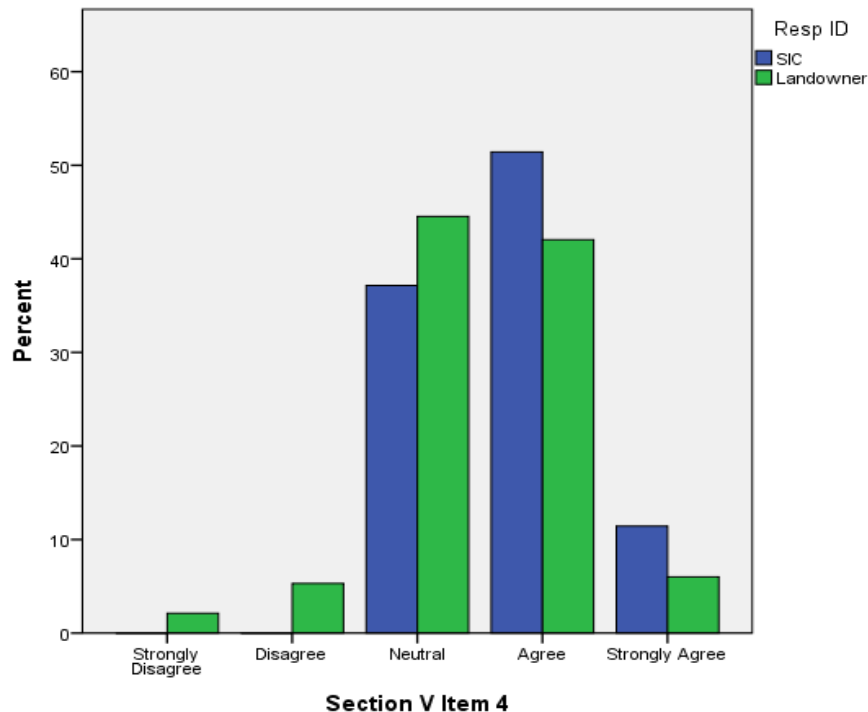


Figure 4: Distribution of responses to item 4, I trust forest certification programs. SIC – Members of the Mississippi SFI Implementation Committee

The distribution of responses to Item 2, non-certified forests are not well-managed, showed a definite tendency to disagree by the SIC ($\bar{x} = 2$, $n = 35$). Landowners ($\bar{x} = 3$, $n = 287$) again were similar, but a higher percentage of respondents agreed to this statement or strongly agreed (Figure 2).

The distribution of responses to Item 3 showed more disagreement by Landowners ($\bar{x} = 4$, $n = 285$) with sustainable forest management as the goal of forest certification. None of the SIC ($\bar{x} = 4$, $n = 35$) responses were in those categories and a higher percentage of SIC respondents agreed or strongly agreed (Figure 3).

Item 4, or the extent to which the respondents trusted forest certification showed in the distribution of responses that overall the SIC ($\bar{x} = 4$, $n = 35$) ranged from neutral to strongly agreed, while a lower percentage of Landowners ($\bar{x} = 3$, $n = 283$) strongly agreed and some respondents disagreed or strongly disagreed (Figure 4).

DISCUSSION

Results of this study indicated that each of the three groups, SIC, MLA, and landowners, had similar responses to the Likert Scales (Table 4), or were in a fairly strong agreement. Analysis did show some significant differences in the distributions of responses to certain items, but the overall scale averages were similar. Likert responses were coded one through five and scale averages for the three groups never varied more than 0.7, or less than one level of response along a response scale from “strongly disagree” to “strongly agree.”

Certification Program Awareness

The entire SIC population was surveyed, and 89% of the MLA had heard of forest certification. This result was expected. The SIC deals with forest certification on a regular basis therefore all of them would be familiar with the topic. Employees and spouses working for logging companies would not necessarily be trained in forest certification like the loggers themselves and did not have knowledge of certification. However, 56.4% of landowner respondents

claimed to have no knowledge about the topic. Interestingly, 64 of the 224 landowners who had heard of certification had not heard of ATFS, of the 290 landowners who had not heard of certification, 34 of them had heard of ATFS. Combining those numbers, 98 landowners or 19% of respondents do not associate ATFS with forest certification. This is unexpected since Mississippi is one of the top ATFS states in the nation. It is not surprising that landowners were not familiar with FSC or SFI, but the expectation was that a larger percentage of them would have been aware of forest certification in general and ATFS in particular.

Section V dealt with respondent understanding and trust of forest certification programs in general. The SIC and the MLA agreed, there were no significant differences between the means of the sum of the scale. MLA and Landowners also showed no significant difference. The only difference in means was between the SIC and the Landowners. Both groups again had high percentages of respondents that agreed certified forests were well-managed, 82.9% of the SIC respondents and 78.4% of Landowners. The SIC had two respondents (5.8%) that disagreed, which in itself was surprising since they were assumed to have a greater understanding and belief in certification. Had those responses been “neutral” like 11.4% of SIC respondents, it would have been less surprising.

Some Landowners (11.4%) tended to agree that non-certified forests were not well-managed, while none of the SIC members agreed. Over 30% of the SIC respondents and almost 50% of Landowners were “neutral” or “unsure.” On the whole, the SIC were more insistent than Landowners that non-certified forests were well-managed, indicating that the need for NIPF landowners to be certified is not that important in terms of sustainability. Most respondents in the SIC and Landowners groups also agreed that the goal of forest certification is sustainable forest management. The SIC had no respondents disagree with that and Landowners had a small percentage (3.6%). Almost 40% of the SIC respondents were “unsure” or “neutral” towards trusting certification programs. This was also a surprising result given that each of the foresters in the SIC manages certified land or purchases wood from certified lands. Related to the trust in forest certification programs, SIC members were “neutral” (68.6%) when asked to agree with the statement “forests should be certified”. Both of these results show a lack of acceptance on the part of professional foresters who deal with certified land and wood, with certification programs in general.

Public Involvement in Management Decisions

Forest certification relies on input from stakeholders in developing standards. There are also indicators within the standards that address public expectations for forest management activities regardless of ownership type. The extent to which respondents felt the public should be involved in forest management decisions was assessed in Sections X, public involvement in federally owned forests through XIII, public involvement in privately owned forests. MLA and the landowners felt more positive about public involvement in forest management than the SIC, across three ownership types; federal, state, and industry. This was an interesting result given that forest certification requires transparency and input from stakeholders, which includes the public. The expectation was that the Landowners and MLA would disagree more than the SIC with public involvement, since the SIC would have been using input from stakeholders in their management plans. Landowners on the other hand, would have little to no experience with public concerns, but unexpectedly, a large number were open to public involvement on federal, state and industry lands.

All three groups of respondents disagreed that the public should have any say in private forest management or have notification prior to management activities. Private forest certification still requires some transparency and public involvement, however none of the programs require that private landowners seek direct input nor are they required to notify the public prior to forest management activities unless required to by local, county, or state ordinance. There are no such laws in Mississippi, these results for MLA and Landowners, therefore, were expected. However, the SIC with its knowledge of and reliance on certification was expected to agree more with public involvement on private lands.

CONCLUSIONS

Overall the responses of the SIC, MLA, and landowners were remarkably similar. The expectation was for a larger disparity among the groups with professional foresters more in agreement with certification than MLA or landowners. The large number of MLA members who agreed with the SIC shows that part of the supply chain has a common understanding and expectation in regard to forest certification.

However, almost a decade after Perera and others (2007) reported that less than half of the landowners in Mississippi and Louisiana understood the concepts of forest certification, this study showed that less than half of the landowners in Mississippi have even heard of forest certification. Foresters and loggers are closer to the day-to-day activities that are required under certification and should understand the concepts better than the landowners. However, to have the same percentage of landowners still not understand the goals of certification or know about forest certification in general, after 10 years, speaks to a need to increase public awareness.

Meeting the goals of forest certification requires a dedicated partnership between the mills, loggers and landowners, all working towards those goals. Otherwise those goals are either not met or are not efficiently realized. Voluntary certification is critically important to forest products companies so they can maintain their social license.

LITERATURE CITED

- Aguilar, F. and R. Vlosky. 2007. Consumer willingness to pay price premiums for environmentally certified wood products in the U.S. *Forest Policy and Economics*. 9:1100-1112.
- American Tree Farm System (ATFS). 2014. Available at: <https://www.treefarmssystem.org/>. Accessed 8/22/14.
- American Tree Farm System (ATFS). 2015. Mississippi database. Accessed 8/25/15.
- Butterfield, R., E. Hansen, R. Fletcher, and H. Nikinmaa. 2005. Forest certification and small forest enterprises: key trends and impacts – benefits and barriers. *Forest Trends*. 59 pp.
- Chen, J., J. Innes, and A. Tikina. 2010. Private cost-benefits of voluntary forest product certification. *International Forestry Review*. 12(1):1-12.
- Dillman, D.A., J.D. Smith, and L.M. Christian. 2009. Internet, Mail, and Mixed-Mode Surveys The Tailored Design Method. John Wiley & Sons, Inc. Hoboken, NJ. 499pp.
- Forest Stewardship Council (FSC). 2015. Public search page. FM Certificates in MS. Accessed 5/22/15. Available at: <http://info.fsc.org/certificate.php#result>.
- Forest Stewardship Council (FSC). 2014. FSC Facts. Forest Stewardship Council, United States. Available at <https://us.fsc.facts-figures.219.htm>. Accessed 8/22/14.
- Forest Stewardship Council (FSC). 2010. FSC-US Forest Management Standard (v-1.0). Forest Stewardship Council U.S. Minneapolis, Minnesota. 109 pp.
- Gordon, J., J. Kushla and A. Londo. 2013. Managing the family forest landowner shortcourse: A case study in Mississippi. *Journal of the National Association of County Agricultural Agents (NACAA)*. 6:1. Accessed on-line at <http://www.nacaa.com/journal/index.php?jid=200>.
- Henderson, J.E. and I.A. Munn. 2013. The economic impact of forestry and the forest products industry on Mississippi's Congressional Districts. Forest and Wildlife Research Center, Research Bulletin FO 449, Mississippi State University. 12 pp.
- Ma, Z., D. Kittredge, and P. Catanzaro. 2012a. Challenging the traditional forestry extension model; insights from the Woods Forum Program in Massachusetts. *Small-scale Forestry*. 11:87-100.
- Ma, Z. B. Butler, D. Kittredge, and P. Catanzaro. 2012b. Factors associated with landowner involvement in forest conservation programs in the US: Implications for policy design and outreach. *Land Use Policy*. 29:53-61.
- Maker, N., R. Germain, and N. Anderson. 2014. Working woods: A case study of sustainable forest management on Vermont family forests. *Journal of Forestry*. 112(4):371-380.
- Minnesota Forest Industries (MFI). 2009. A lot goes into caring for Minnesota's forests. Minnesota Forest Industries. Duluth, Minnesota. 12 pp.
- Moffat, K., J. Lacey, A. Zhang, and S. Leipold. 2015. The social license to operate: a critical review. *Forestry An International Journal of Forest Research*. Institute of Chartered Foresters. 0,1-12.
- Moore, S., F. Cubbage, and C. Eicheldinger. 2012. Impacts of Forest Stewardship Council (FSC) and Sustainable Forestry Initiative (SFI) forest certification in North America. *Journal of Forestry*. 110(2):79-88.

- Oswalt, S. N. 2013. Mississippi, 2011 forest inventory and analysis factsheet. E-Science Update SRS-063. Asheville, North Carolina: U.S. Department of Agriculture Forest Service, Southern Research Station. 4 pp.
- Perera, P., R. Vlosky, G. Hughes, and M. Dunn. 2007. What do Louisiana and Mississippi nonindustrial private landowners think about forest certification? *Southern Journal of Applied Forestry*. 31(4):170-175.
- Poudel, J. 2014. Economic impacts of fishing, hunting, and wildlife-associated recreation expenditures across the U.S. South. Master's Thesis. Department of Forestry, Mississippi State University. 85 pp.
- Schreiber, J. 2012. A cost benefit analysis of forest certification at The Forestland Group. Master's Thesis. Nicholas School of the Environment, D.U.K.e University. 72 pp.
- Sullivan, G.M. and A.R. Artino. 2013. Analyzing and interpreting data from Likert-Type scales. *Journal of Graduate Medical Education*. December: 541-542.
- Sustainable Forestry Initiative (SFI). 2014. Future Forests: 2014 Progress Report. Sustainable Forestry Initiative. Washington D.C. Available at: <http://www.sfiprogram.org/files/pdf/2014-sfi-progress-report-spreads/>. Accessed 8/22/14.
- Sustainable Forestry Initiative (SFI). 2015a. SFI 2015-20190 Forest Management Standard. Sustainable Forestry Initiative. Washington D.C. 12 pp.
- Sustainable Forestry Initiative (SFI). 2015b. Public search of MS certificates. Available at: <http://64.34.105.23/PublicSearch/SearchSFIForests.aspx>. Accessed 5/22/15.
- Taylor, D. 2009. Logging Capacity Survey Summary Report, 2008 Update. Wood Supply Research Institute. Washington D.C. 22 pp.
- Taylor, D. 2012. WSRI Supplier Communication Relations Project: How Can We Change the Culture of a Supply System in Crisis? *Forest Operations Review*. Spring: 8-13.
- The Law Dictionary. 2015. On-line resource featuring Black's Law Dictionary. Thomas West Publishing. St. Paul, Minnesota. Available at: <http://thelawdictionary.org/social-benefit/> Accessed 3/8/2015.
- United Nations. 1987. Report of the world commission on environment and development: Our common future. Annex to A/42/427. United Nations. New York. 247 pp.
- University of California Los Angeles (UCLA). 2016. Introduction to SPSS. Statistical Consulting Group. From <http://www.ats.ucla.edu/stat/spss/faq/alpha.html>. (accessed 1/17/16).

FACTORS AFFECTING LANDOWNER PERCEPTIONS CONCERNING LANDSCAPE HETEROGENEITY IN SOUTHERN GREAT PLAINS

Omkar Joshi and Sam Fuhlendorf¹

Abstract—Agricultural intensification has fragmented rangelands in the Great Plains, which has contributed to uniform and homogenous landscapes and decreased biodiversity. Alternative land management practices involving fire-grazing interactions can help maintain biodiversity without affecting livestock productivity. A survey was designed to understand the factors that influence preferences among the general population toward landscape heterogeneity. Given the ordinal nature of survey responses, requisite data were analyzed using a generalized ordinal logit model. Results suggested that respondents who realized an importance of open space and those who recognized a need for varying mix of uniform grasses and grasslands preferred landscape heterogeneity. Female respondents were more than two times likely to prefer heterogeneous landscapes compared to male respondents. In contrast, population groups providing higher importance towards wildlife habitat did not prefer heterogeneous landscapes. Results suggest the need for extension and outreach activities to educate certain segments of general population regarding benefits of alternative management practices that support landscape heterogeneity in the Great Plains.

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CONTINGENT VALUATION ESTIMATES OF WILLINGNESS TO PAY TO PRESERVE WATERFRONT OPEN SPACE IN MISSISSIPPI AND ALABAMA

Ram P. Dahal, Robert K. Grala, and Jason S. Gordon¹

Abstract—Waterfront open spaces are dynamic places and represent an interface between aquatic and terrestrial communities. Waterfront open space provides environmental benefits, recreational opportunities, and opportunities for water-dependent economic activities (e.g., ports, boat yards, marinas, fishing docks, seafood markets, and others). Benefits from waterfront open space are critical to coastal communities and their visitors. However, with a growing population and urbanization, these areas compete with various land use changes. Rapid growth presents important challenges for elected officials, planners, and natural resource managers because urban development can increase stress on the landscape and compromise environmental quality and community resilience. This study evaluated residents' willingness to pay (WTP) to preserve waterfront open space in coastal regions of Mississippi and Alabama. A contingent valuation method (CVM) was employed to estimate citizen's WTP. The CVM involved two scenarios where citizens voted for or against the waterfront open space preservation program with offered bid amount ranging from \$1 to \$100. This approach enabled us to estimate their WTP to support open space preservation. Study data were collected via mail survey. Study findings suggested the majority of residents valued waterfront preservation. They also believed that commercial development, as opposed to other types of development such as residential, was the major growth issue in the community. While respondents valued open space preservation, they also recognized importance of some forms of economic development. Results will help guide local elected officials in maintaining a balance between urban development and waterfront open space, and access to associated benefits of both.

Keywords: Mail survey, Contingent valuation method, waterfront open space

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Concurrent Session 4B Policy and Property Taxation

REFORM AND EFFICIENCY OF STATE-OWNED FOREST ENTERPRISES IN NORTHEAST CHINA

Xue Han, Gregory E. Frey, Yude Geng, Frederick W. Cubbage, and Zhaohui Zhang¹

Abstract—The Chinese government has sought to reform state-owned forest enterprises (SOFEs) because of their past financial losses and environmental degradation. Previous assessments of SOFEs technical efficiency have used small samples, short time periods, and viewed SOFEs as profit-maximizers. However, statements from the Chinese government suggest that the objective of SOFEs is not profit maximization, but production of various benefits for the community and nation. With this in mind, we used a theory of SOFEs as “social firms” to classify inputs and outputs, and data envelopment analysis to measure the efficiency of 86 SOFEs from 2003 to 2009. We found no overall trend in variable return to scale efficiency, providing no evidence of better management over time. At the same time, there were decreases in scale efficiency primarily due to higher levels of government investment. We compared groups of SOFEs that underwent a specific pilot forest tenure reform to those that did not, and we found no evidence to support that tenure reform improved technical efficiency.

Keywords: data envelopment analysis; technical efficiency; forest tenure reform; social firm

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CURRENT USE VALUATION OF TIMBERLAND FOR PROPERTY TAX PURPOSES IN THE SOUTH: A COMPARATIVE ANALYSIS

Yanshu Li¹

Abstract—Nearly all southern states have adopted certain preferential taxation programs that reduce property taxes of qualified forestland for the purpose of conserving green space and fostering sustainable forestry. This practice, normally called current use programs, allows local tax assessors to value forestland based on its ability to generate income from timber production instead of higher fair market values. To improve uniformity in timberland taxation in the state, most states have mandated their state revenue department to develop methodologies of forestland current use valuation or even provide current use value schedules for assessors to adopt. However, each state in the South has their own valuation methods and different approaches to estimate major elements of the formula. As a result, there is great variation in the final use values of forestland for property tax purpose.

The purpose of the study is to assess the approaches used by each state for current use valuation of forestland, investigate the causes of the disparity in use values of forestland in the region, and discuss ways to improve. The study is conducted by gathering forestland property taxation policies and information from various sources, comparing and assessing the methodologies of current use valuation adopted by each state, and comparing the average use values of each state for the most recent years and investigating the causes of disparity.

The study found that state methods of current use valuation of forestland for property tax purpose are far from uniform. Methods or ways to estimate major elements of income, management costs, and discount rates are often inaccurate and arbitrary. These will inevitably have implications on uniformity of taxation and shifting of property tax burdens. In the end, the study proposes ways to improve and calls for a theoretically sound and harmonized methodology.

Keywords: current use valuation, property taxation, forestland valuation method

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STATE PROPERTY TAX INCENTIVES PROMOTING ECOSYSTEM SERVICES FROM PRIVATE FORESTLAND IN THE UNITED STATES

Michael A. Kilgore, Paul V. Ellefson, Travis J. Funk, and Gregory E. Frey¹

Abstract—All 50 states in the U.S. offer programs to reduce the property tax burden on forest landowners in certain cases. These tax incentive programs are motivated by the fact that forests provide numerous ecosystem services and require few governmental services. In 2015, we compiled information on existing property tax incentive programs for private forestland in all 50 states from current literature; state laws and regulations; and websites of state agencies, universities, and independent groups. We used this information to identify ecosystem services promoted; compare and contrast requirements, organization, and administration; and estimate magnitude of financial benefits and number of participants and acres affected. These programs promote ecosystem services including open space and scenic resources, conservation of soils and wetlands, protection and supply of fish and wildlife, protection and supply of water, production of timber and fiber products, recreational uses and resource preservation, and integrity and sustainability of forests. In 2014, state property tax programs enrolled nearly 210 million acres of forestland nationwide. The immediate beneficiaries of these programs were the more than 3.85 million participants, who received more than \$1.61 billion in annual property tax relief for purposes of promoting ecosystem services. The annual value of this relief was an acre-weighted average of \$7.68 per acre.

Keywords: property tax, incentive programs, ecosystem services

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Concurrent Session 5A Challenges in Mississippi Forestry

SOCIOECONOMIC AND ECOLOGICAL FACTORS ASSOCIATED WITH THE PRESENCE AND ABUNDANCE OF INVASIVE TREE SPECIES IN MISSISSIPPI AND ITS MANAGEMENT IMPLICATIONS

Jun Zhai, Donald L. Grebner, Zhaofei Fan, Robert K. Grala, and Ian A. Munn¹

Abstract—Invasive plant species have negatively affected the ecological landscape. Previous research has not typically considered the effects of socioeconomic factors to the presence and abundance of invasive tree species. Using Forest Inventory and Analysis and other data sources, this study identified ecological and socioeconomic factors contributing to the presence and abundance of invasive tree species in Mississippi from 2009 to 2015 at the county level. Classification and regression trees were employed to cluster and select relevant factors to spatially analyze their impact on presence and abundance. Study results indicate that the presence of invasive trees across a landscape depends on elevation, per capita mean annual income, type of ownership, the abundance of invasive tree species depends on elevation, per capita mean annual income and successional age. At higher elevations, invasive tree species found in Mississippi were less likely to occur and be less numerous. Per capita mean annual income is positively related to the occurrence and density of invasive trees. Our results suggest that invasive trees are more commonly found on private forestlands and young and newly established forests. Management activities that monitor and control invasive trees in Mississippi should focus on private forestlands at low elevation, younger forests and counties with higher average income. These findings will help private and public landowners and policymakers to micro-target areas of highest potential risk and more effectively use budgetary resources for monitoring and control.

Keywords: invasive tree species, presence, abundance, spatial lag model

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HUNTING ACTIVITIES OF UNDERGRADUATES IN MISSISSIPPI, 1995-2016

Stephen C. Grado and Marcus K. Measells¹

Abstract—Hunter numbers and activity days in the United States have been declining relative to U.S. population growth, with similar trends in Mississippi. An annual survey was administered to undergraduate students enrolled in Forest Recreation Management at Mississippi State University to determine how many hunted, their hunting activity days (ad), and differences in national and state trends. Specific issues included number of days hunting, location by landownership, and species preferences. In 1995, 90 students pilot tested the survey, and subsequently changes were made. From 1996 to 2016, 849 students took the survey with no refusals, however, 124 were absent during survey administration. Of those who responded, 78.9% hunt (N=670) with mean number of days hunting in Mississippi ranging from 26.5 ad in 1997 (N=62) to 97.6 ad in 2002 (N=28). In general, from 1996-2016 there was a slight increase in mean number of Mississippi hunting days. One noteworthy observation was that mean number of days in 2002 was significantly higher than 12 other years. There were 2.95 private land activity days for every public land activity day. The highest number of activity days on public land occurred on National Wildlife Refuges (26.5%), while on private land with fees it was leased nonindustrial private lands (61.4%), and on private lands without fees it was nonindustrial private lands (98.7%). While this sub-set does not represent all hunters, it is an important group that may reflect on issues confronting future hunter recruitment not only in Mississippi but the U.S. as well.

Keywords: Hunting participation, Mississippi, recreation, student activities

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NONINDUSTRIAL PRIVATE FOREST LANDOWNER OBSTACLES TO PARTICIPATION IN CARBON SEQUESTRATION IN THE SOUTHERN UNITED STATES: A DIFFUSION OF INNOVATIONS PERSPECTIVE

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Abstract—Forest carbon sequestration, resulting in increased carbon storage in forests, is an effective tool for climate change mitigation. Nonindustrial private forest (NIPF) landowner participation is crucial for increasing carbon stocks in southern forests. Carbon sequestration is a relatively new practice, so NIPF landowners were expected to have varied adoption responses depending on their different internal and external environments. This study identified major obstacles for NIPF participation in carbon sequestration and identified landowner adoption categories with respect to carbon sequestration using the diffusion of innovations model. Principal component analysis was used to identify five major obstacles to participation in carbon sequestration programs: management requirements, forest characteristics, owner preferences, normative reasons, and understanding. NIPF landowners were grouped into three adoption categories: adopters (18%), late adopters (60%) and laggards (22%). The adopters, compared to the other categories, were richer, more educated, relatively younger, and owned larger landholdings.

Keywords: Adoption Behavior, Segmentation, Factor Analysis, Participation, Obstacles

INTRODUCTION

Forest carbon sequestration is an important strategy for climate change mitigation. Trees sequester about 15% of total CO₂ emissions in the United States, which makes them a critical tool for reducing atmospheric CO₂ (U.S. Environmental Protection Agency, 2011). Managing southern forests for atmospheric carbon removal is an economical and efficient approach for climate change mitigation because trees increase carbon storage while offsetting emissions by industrial and other polluters through emission reduction credits (Malmsheimer and others 2008). Depending on the management treatments they receive, forests could serve as a source, as well as a sink, of atmospheric carbon. Forest type and ownership goals determine the effectiveness of management treatments, such as longer rotation, reduced disturbance, or increased productivity, in increasing the carbon stock of a forest. In general, forest management strategies that increase timber volume or biomass production often support higher forest carbon sequestration levels (Hoover and Stout 2007). The southern United States has an estimated potential to sequester about 23% of the regional total CO₂ emissions (Han and others 2007).

In the southern United States, where highly productive forests dominate the landscape and about two-thirds of the land is under private ownership, nonindustrial private forest (NIPF) landowners' choice of forest management strategies will have an important role in climate change mitigation and carbon sequestration. About 40% of the NIPF forest land in this region is estimated to be potentially available for carbon sequestration (Galik and others, 2013, Murray and others, 2005). The potential strategies for increasing forest carbon sequestration on NIPF lands include increasing acres devoted to carbon sequestration and implementing strategies to increase carbon storage at stand level. However, NIPF landowners in the South are a heterogeneous group with varied reasons for owning

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forest land (Khanal and others, 2017a; Majumdar and others, 2008) and very diverse management objectives (Arano and Munn 2006, Butler 2008, Joshi and others 2015) which could create difficulties in implementing these strategies.

Earlier studies analyzing NIPF landowner participation in forest carbon sequestration programs can be broadly grouped into two classes based on the theoretical model they employed to explain the participation behavior of the landowners. One set of studies involved utility maximization as the rational for NIPF landowners' interest toward carbon sequestration using econometric models to identify factors affecting their decision (Dickinson and others 2012, Markowski-Lindsay and others 2017). These econometric models found that sequestration program characteristics and financial reasons, as well as socioeconomic, understanding, and climate change attitudes, had significant effects on NIPF landowner decisions to participate in carbon sequestration programs. A second set of studies used planned behavior theory to explain NIPF participation in carbon sequestration activities (Khanal and others, 2016; Thompson and Hansen, 2012). These studies found similar results for southern landowners, but that not every landowner is willing or qualified to participate in carbon sequestration programs and that landowner socioeconomic factors were strongly associated with their attitudes and beliefs toward carbon sequestration (Khanal and others, 2017b; Soto and others, 2016).

To explain the adoption of new practices, such as carbon sequestration programs, some studies have applied sociological theories like the diffusion of innovations model (Rogers, 2003), which describes transfer and adoption of new practices or technologies through a social system over time. Forest carbon sequestration is a relatively new practice, so it is highly plausible that NIPF landowners would adopt carbon sequestration practices following that model. That is, not every landowner would be expected to adopt carbon sequestration programs at the same time, but rather to follow a temporal pattern of adoption. Doolittle and Straka (1987) first used this theory to evaluate forestry regeneration behavior of forest landowners in the southern United States. Later studies expanded its application to evaluation of adoption behavior and forest policy (Rametsteiner and Weiss, 2006) and to identify important communication channels used by forest landowners that influenced their adoption behavior and participation in voluntary protection activities (Korhonen, 2013).

The goal of this study was to apply the diffusion of innovations theory to NIPF landowner management situations and to evaluate empirical data related to their perceived obstacles for voluntary participation in carbon sequestration programs. The specific objectives were to identify major barriers for voluntary participation in carbon sequestration activities in the southern United States, to identify adoption categories of NIPF landowners with respect to carbon sequestration, and to evaluate the association of the adoption categories with NIPF landowners' socio-economic characteristics.

Diffusion of Innovations Model

The diffusion of innovations model examines the spread of new practices or products into a social system over time and provides a definition of adoption categories depending on when an individual adopts a new idea (Rogers, 2003). It takes time for a new practice to be adopted in a social system because people have varied risk-taking behaviors. This theory groups people into multiple categories depending on how long it takes for them to adopt a new technology or practice. The diffusion of innovations model describes an underlying process that occurs as people adopt new practices in a social system.

This theory proposes five groups of individuals based on how, why, and at what rate the individuals adopt a new idea as compared to other members of a social system: innovators, early adopters, early majority, late majority, and laggards. The first group, innovators, are the venturesome, change agents, and risk-takers who are the first people to adopt any new invention or practice, while the laggard are mostly the followers, suspicious of new practices, and prefer the status-quo. Within a society, the early adopters, early majority, and late majority are likely to serve as opinion leaders, deliberate contact agents, and followers, respectively (Kaminski, 2011).

This theory highlights the importance of communication and peer-group learning for the adoption of a new practice in forestry. The innovators could serve as peer educators, while the early adopters and early majority served as opinion leaders or educators to the late majority and laggards concerning new practices such as forest carbon sequestration. The basis of the theory is the importance of communication channels for reaching out to landowners who put higher value on the opinion and practices of fellow or neighboring landowners.

METHODS

Data for this study were collected using a mail survey of NIPF landowners with forest land in 11 states in the southern United States (AL, AR, GA, FL, LA, MS, NC, OK, SC, TX, VA). Counties without loblolly/shortleaf (*Pinus taeda*/*Pinus echinata*) or longleaf/slash (*Pinus palustris*/*Pinus elliottii*) pine forest groups based on Forest Inventory and Analysis (FIA) data were excluded from the survey. A contingent rating scenario included in our survey questionnaire required majority responses from NIPF landowners with pine forest types, but due to lack of such an exclusive database of the landowners, counties lacking the forest types were excluded. The names and addresses of NIPF landowners were purchased from List-Giant, a private database vendor that compiles forest landowner lists based on county tax roll records. Thompson and Hansen (2012) also used the same vendor database for their NIPF forest carbon sequestration study. Additionally, consistent with previous landowner studies, our sample population did not include landowners with less than 10 acres of forest land in the selected counties (Butler, 2008; Thompson and Hansen, 2016).

To prepare a survey questionnaire with clearly understandable questions and to elicit accurate information from landowners, a draft instrument was prepared and revised after review and input from NIPF researchers. Then, the draft survey was pretested at county forestry association meetings in Mississippi (Jefferson and Lee Counties) and subsequently refined. The final survey questionnaire included 32 questions using 5 pages. The survey instrument included three sections: forest land characteristics, environmental preferences, and socio-economic details. Forest land characteristics addressed property size and type, ownership goals, and forest management strategies. Climate change, understanding of carbon sequestration, and interest related questions were in the environmental preference section and the last section included income, education, and other demographic related questions.

The survey was sent to 5,000 randomly selected landowners in the fall of 2013 following the Dillman (2000) tailored design method for conducting mail surveys. There were three mailings and the time between successive mailings was approximately 3-4 weeks. Each mailing included a signed cover letter, a survey questionnaire, and a postage-paid return envelope. A reminder postcard was sent to non-responding landowners between the first and second mailing only.

Statistical Analysis

Respondent ratings of the statements in Table 1 formed the basis for identifying NIPF barriers to participation in carbon sequestration. Results of the earlier studies were used to develop the list of questions, which identified various factors influencing NIPF landowner participation in carbon sequestration. Respondents rated each statement using a Likert scale that ranged from one (strongly disagree) to five (strongly agree) with three indicating a neutral category. By using landowner rating responses in each statement, principal component analysis (PCA) was used to identify unobservable latent factors that contributed to the variation in ratings of the objective statements. In other words, for each principal component dimension, higher component loading with original variables (i.e., correlation between original variables and the principal component) provided a basis for their naming and interpretation. Components with greater than one eigenvalue were retained.

A non-hierarchical k-means analysis was applied to the landowner ratings of the obstacle statements. In this method, the final cluster centers are the mean of observations assigned to each cluster at complete convergence. Minimization of the sum of squared distances from cluster means ensured that the observations that were very close to each other got grouped into the same cluster, while the relatively distant observations fell into separate clusters. The R software package, NbClust, was used to compare 30 different indices to determine number of clusters and suggest the best clustering option, which was then applied to validate the clustering solution (Charrad and others, 2014). Then, the Pearson chi-square test of independence was used to test the association among adoption categories and socio-economic variables.

Table 1: Principal component analysis applied to 19 barriers of participation statements related to carbon sequestration to identify five major obstacles for NIPF landowners in the southern U.S.

Barriers for Participation	Obstacles				
	Revenue Implications	Forest land	Owner	Normative reasons	Under-standing
It may decrease my revenue from forest land	0.84	0.12	0.09	0.11	0.16
It could be in conflict with other management goals	0.79	0.14	0.21	0.10	0.05
I worry this might decrease my property value	0.77	0.16	0.13	0.26	0.10
I think there is too much risk to implement this	0.52	0.27	0.39	0.19	-0.05
My forest characteristics not suitable for this	0.18	0.81	0.18	0.09	0.03
I don't own enough land to implement this	0.12	0.71	0.20	0.10	0.28
I don't spend enough time on my land for this	0.02	0.65	0.13	0.12	0.42
My other land contract obligations restrict me	0.37	0.61	0.03	0.08	-0.19
I don't want to change current management practices	0.21	0.10	0.78	0.14	-0.03
Too old to plan for carbon sequestration now	0.23	0.26	0.67	0.21	0.11
Not willing to spend more money to implement	0.12	0.14	0.59	0.08	0.32
None of neighboring landowners are doing this	0.15	0.01	0.01	0.86	0.17
None of my neighbors are interested in this	0.19	0.17	0.24	0.86	0.04
My family and friends are not interested in this	0.23	0.23	0.41	0.64	0.04
I don't know where to get advice about this	0.18	0.02	-0.04	0.05	0.82
I know very little about this to practice myself	0.03	0.24	0.17	0.12	0.71
No thoughts about forest carbon sequestration	-0.04	0.02	0.50	0.06	0.56
Cronbach α	0.82	0.74	0.68	0.82	0.65

RESULTS

Out of 5,000 surveys sent to the randomly selected landowners, only 4,671 were valid addresses due to discounting bad address, deceased individuals, or no forest ownership. There were 735 completed responses received, resulting in a response rate of 15.7%. The low response rate may be likely due to political sensitivity of the climate change topic, limited understanding about climate change mitigation and forest carbon sequestration, and the complicated nature of the contingent rating scenarios included in the survey. To check for the non-response bias, telephone surveys were conducted to 50 randomly selected non-responding landowners and they were asked four key questions related to their forest area (i.e., size of largest forested parcel), management behavior (i.e., availability of a written forest management plan), climate change attitude (i.e., whether human activities are contributing to climate change), and education. Comparisons between responding and non-responding landowners using a t-test in terms of the four key questions did not find any statistical difference at the 5% significance level. Another comparison was made between first and last responding 100 landowners in terms of their forest area, age, and education. No statistical difference was found from t-tests of the selected variables between the first and last responding landowners.

Barriers for Participation in Carbon Sequestration

The results from PCA of the 19 rating variables describing landowner barriers to managing their forest for carbon sequestration are presented in [Table 1](#). The PCA described 79% of the variation when five major components were retained with a decision criterion of eigenvalue greater than 1. From the PCA, NIPF landowners' barriers to participation in carbon sequestration programs in the southern United States were broadly reduced into five major obstacle types: revenue implications, forest land, owner, normative reasons, and understanding. The component loading coefficients of the barrier statements were between 0.86 to 0.52, indicating a strong correlation of the 19 statements with their associated new obstacle types. The statements "decrease my revenue," "conflict with my other management goals," "might decrease my property value," and "risk to implement" can be thought of as describing the revenue implications related to implementing forest carbon sequestration. The loading coefficients of these statements were between 0.84 and 0.52. The statements "forest characteristics not suitable," "not enough forest land," "don't spend much time on forest," and "other forest land contracts restrict" can be thought as describing their forest land characteristics related barriers for implementing carbon sequestration. These statements had loading coefficients between 0.81 and 0.61. The statements "don't want to change my current practices," "too old to plan," and "no willingness to spend" are owner characteristics related barriers for participation in carbon sequestration. The loading coefficients of these statements were between 0.78 and 0.59. The statements "none of the neighboring landowner doing," "none of neighboring landowner participating," and "family and friends not interested" could be attributed as normative reasons for participation in carbon sequestration. These statements had loading coefficients between 0.86 and 0.64. The statements "where to get advice," "know little about this," and "never thought about it" could be attributed as the understanding related obstacles for participation in carbon sequestration. These statements had loading coefficients between 0.82 and 0.56.

Adoption Categories of NIPF Landowners

Results of the cluster analysis indicated that the survey respondents could be broadly grouped into three major categories (adopters, majority, and laggards) based on their rating of the 19 statements. In [Table 2](#), the adopters were 18% of the total respondents, owned 25% of forest acres in the southern United States, and had relatively lower ratings in each of the five barriers to participation in carbon sequestration. Among the adopters, the obstacle with highest average rating was revenue implication. The majority represented 60% of the survey respondents, owned 60% of the forest land, and had higher ratings for revenue, forest land, and understanding obstacles as compared to the early adopters. Their rating of the normative causes was between early adopters and laggards. The other group, laggard was 22% of the survey respondents, owned 15% of the forest land, and they rated all the five obstacles highest as compared with other two groups. In particular, the normative reasons received the highest average rating within this group.

Table 2: Adoption categories of forest landowners, percentage in each category with respect to number of landowners and acre of forest land, and average rating of the obstacles for participation by each adoption category.

Adoption Categories	% of N	% of Acres	Mean Participation Obstacles*				
			Revenue implications	Forest land	Owner	Normative reasons	Understanding
Adopters	18	25	2.3	1.9	2.4	2.0	2.0
Majority	60	60	3.0	2.8	3.1	3.1	3.0
Laggard	22	15	3.6	3.3	3.9	4.3	3.7

*Mean participation obstacles indicate average of the Likert scale rating between 1 to 5 with 1 (strongly disagree) to 5 (strongly agree) and 3 (neutral) response.

Socio-Economic Association of NIPF Landowner Adoption Categories

Results indicated that the three adoption categories were different in terms of the respondents' socio-economic characteristics, forest holding size, and management behavior as presented in Table 3. There were significant differences among the three adoption categories and their age distribution ($\chi^2 = 19.59$, $P < 0.0033$). In general, more than half of the landowners in all three adoption categories were over 60 years of age, but of the less than 50 years old landowners, more landowners were early adopters (16%) than the majority (11%) and laggards (6%). Similarly, there were significant differences among the three categories in terms of their annual household income distribution ($\chi^2 = 43.65$, $P < 0.0002$). The most frequent income category for early adopters (37 %) was income between \$62,500 and \$112,500, but it was less than \$37,500 for those in late adopters (30 %) and laggard (44%). Among early adopters, 38% of the respondents were in income category greater than \$112,500 as compared to 17% and 14% in late adopters and laggards, respectively.

The adoption categories were significantly different in terms of their forest land size ($\chi^2 = 26.68$, $P < 0.0002$) and the availability of a forest management plan ($\chi^2 = 12.54$, $P < 0.0019$). The most common forest size among the three adoption categories was between 100 to 500 acres. More than 22% of the early adopters had a forest land area greater than 500 acres as compared to late adopters and laggard groups with 8% and 2%, respectively. In terms of use of a forest management plan, more than 59% of the landowners in all three adoption categories did not have one. In early adopter group, 40% of the landowners had a management plan but the late adopters and laggard groups with management plan were only 22% and 25%, respectively.

DISCUSSION

This study identified major obstacles for NIPF landowner participation in carbon sequestration programs and segmented landowners based on their adoption behavior towards new practices such as carbon sequestration in the southern United States. The five major obstacles for landowner participation were revenue implications, forest land, owner characteristics, normative reasons, and understanding of carbon sequestration. These findings are consistent with earlier published results related to factors affecting NIPF landowner participation in carbon sequestration. For the NIPF landowners in Massachusetts, Dickinson and others (2012) found that requirements for enrollment and longer time commitment negatively affected landowner participation, while education was positively associated with participation in carbon sequestration programs. Similarly, Markowski-Lindsay and others (2011) found that management objectives, harvesting behavior, land size, and owner's income and age influenced landowners in Massachusetts to participate in carbon sequestration programs. Among the southern landowners, Khanal and others (2017b) indicated that their socioeconomics, resource characteristics, and understanding affected landowner participation in carbon sequestration. The landowner related factors such as attitudes were important factors affecting their participation in carbon sequestration (Khanal and others 2016, Thompson and Hansen 2012). The normative reason was also an important factor for some forest landowners because they preferred to adopt tried and tested techniques to avoid risk from new practices such a carbon sequestration.

Table 3: Chi-square test of association among three adoption categories and their socio-economic characteristics in southern U.S.

Variables	Adoption Categories (%)			X ²	Prob.
	Adopters	Majority	Laggard		
Management Plan Availability				12.54	0.0019
No	59.18	77.12	75		
Yes	40.82	22.88	25		
Land Size (acres)				26.68	0.002
<100	15.22	28.57	33.33		
100 – 500	61.96	62.34	63.16		
500 – 100	15.22	5.52	1.75		
>1000	7.61	3.57	1.75		
Income				43.65	0.0002
<37,500	16.84	30.56	44.14		
37,500 – 62,500	6.32	17.28	16.22		
62,500 – 112,500	37.89	23.59	25.22		
112,500 – 175,000	18.94	10.96	6.3		
>175,000	20	17.6	8.11		
Age				19.59	0.0033
<40	3.00	2.69	2.38		
40- 50	13.00	9.85	4.76		
50- 60	32.00	21.79	13.49		
>60	52.00	65.67	79.37		

Based on the rating of participation obstacles, there were three major landowner categories related to adoption of carbon sequestration practices in the southern United States. According to the diffusion of innovation model, there could be five categories of people related to the adoption of new technology or practice; however, this study found three major groups of landowners relevant to adoption of forest carbon sequestration practices. There could be two possible explanations for this difference. NIPF landowners in the southern United States are relatively affluent, older, and less educated than the general population (Butler, 2008), so they could be considered a unique group, not a random sample of the general public in the region. These unique attributes of the NIPF landowners in the southern United States might have contributed to make the early and late categories less distinctive, unlike suggested in the theoretical model. The other reason might be the lower understanding of forest carbon sequestration among NIPF landowners.

In Khanal and others (2017b), only 40% of the NIPF landowners in the southern United States indicated having a good understanding of forest carbon sequestration. Additionally, among the three groups, the laggard group of landowners rated normative reasons as the most important factor along with other barriers. The laggard group is

characterized as very inactive and risk-averse, and likely to follow practices adopted by their fellow landowners (Doolittle and Straka, 1987). Schubert and Mayer (2012) found that neighboring landowners influence in forest management decisions of their peers and Vokoun and others (2008) identified the need for cooperation in forest management decisions by different NIPF landowners in Virginia. This peer group influence could be more effective in influencing forest management behaviors of the laggard landowners.

Conversely, the adopter group of landowners had lower ratings across all the five obstacle categories as compared with the other two categories. Their major concerns were related to implications of participation in the sequestration practices. The obstacle rating of the majority group landowners was between early adopters and laggard categories, and they could be considered as the followers of the adopter group. The adopter group landowners could serve as change agents or opinion leaders for forest carbon sequestration among NIPF landowners, while the majority group serves as contact agents for the laggard group of landowners.

The landowner categories varied in terms of their socio-economic and behavioral characteristics as well. As compared with landowners in majority and laggard categories, landowners associated with adopter category were relatively young, had higher incomes, and held larger forested parcels. In other words, landowners in the adoption category were relatively young and adventurous with more education, income, and tract size, and were more receptive to alternative forest management practices. The landowners with larger land size, longer forest ownership tenure, and higher education had a management plan and they were more active forest managers (Joshin and others 2015). Kline and others (2000) found that landowners with higher income and land size were more interested in protection and stewardship practices, especially if additional incentives were provided. Also, some of the landowners associated with majority would likely get involved because they would prefer to keep up with competitors and more likely adopt proven trends in forestry practices. The laggard groups were relatively older and passive landowners, so they would largely follow the lead of other two groups in terms of adopting new practice such as carbon sequestration.

The adopter and majority categories would be more valuable groups to concentrate for gaining acres of carbon sequestration in the southern United States. With proper communication strategies to influence the forest management behavior of these two groups of NIPF landowners, they would likely be the most receptive group for the carbon sequestration information if supplemented by adequate incentive provision. Landowners associated these two groups are likely be active managers, so the passive management practices like carbon may not be suitable for all of them; however, those willing to participate could be used as change agents or resource persons for their peer landowners. This suggests that early adopters and majority would be the most important groups to concentrate for promoting carbon sequestration because they are the most likely group to change forest management behavior. Also, they would likely be able to influence forest management behavior of fellow landowners.

Measells and others (2005) found that NIPF landowners in Arkansas, Louisiana, Mississippi, and Tennessee had varied preferences to receive forestry-related educational programs depending on their sociodemographic characteristics, forest land size, and reasons for owning forestland. Therefore, these adoption categories would require different communication strategies to influence behavior related to forest management practices. In the context of changing forest landscape, like shrinking forest acres, communication to pursue NIPF landowners in ecosystem services or carbon sequestration is essential, but complicated (Belin, 2005). That means, diverse channels of communication would be required to approach the landowners associated with the different adoption categories.

The early adopter categories are more likely be active, information seeking, and relatively young landowners, so they would be easily accessible group to deliver information related to carbon sequestration. The laggard group would be more passive in terms of management and information seeking behavior, so it could be difficult to connect with these landowners. The early adopters or majority might be willing to adopt new practices with little information, but laggard group will require site visits or demonstration tours for convincing that the new information will actually work for them. Therefore, multiple communication strategies would be beneficial to influence adoption behavior of potential landowners that might be willing to participate in conservation and carbon sequestration activities.

CONCLUSION

This study has highlighted some important issues related to involving NIPF landowners in forest carbon sequestration in the southern United States. The results of this study would be useful to identify potential clientele and to effectively communicate the conservation and carbon sequestration programs. The communication strategies, such as site visits, “walk in the woods,” or demonstration tours, could prove to be useful for increase carbon sequestration acres in the South. It would require adequate incentives or policy support to enroll a significant percentage of landowners in this region. Our results point to a need for diverse and tailored approach to communicate with NIPF landowners with diverse adoption characteristics and obstacles to participate in carbon sequestration. In order to estimate number of landowners and acres available for forest carbon sequestration in the southern United States, future studies with specific requirements of participation is suggested.

LITERATURE CITED

- Arano, K.G.; Munn, I.A. 2006. Evaluating forest management intensity: a comparison among major forest landowner types. *Forest Policy and Economics*. 9(3): 237-248.
- Belin, D.L.; Kittredge, D.B.; Stevens, T.H.; Dennis, D.C.; Schweik, C.M.; Morzuch, B.J. 2005. Assessing private forest owner attitudes toward ecosystem-based management. *Journal of Forestry*. 103(1): 28-35.
- Butler, B.J. 2008. Family forest owners of the United States, 2006. General Technical Report NRS-27. Newtown Square, PA: USDA Forest Service, Northern Research Station. 72 p.
- Charrad, M.; Ghazzali, N.; Boiteau, V.; Niknafs, A. 2014. NbClust: an R package for determining the relevant number of clusters in a data set. *Journal of Statistical Software*. 61(6): 1-36.
- Dickinson, B.J.; Stevens, T.H.; Lindsay, M.M.; Kittredge, D.B. 2012. Estimated participation in U.S. carbon sequestration programs: a study of NIPF landowners in Massachusetts. *Journal of Forest Economics*. 18(1): 36-46.
- Dillman, D.A. 2000. Mail and internet surveys: the tailored design method. 2^d ed. New York, NY: John Wiley & Sons, Inc. 464 p.
- Doolittle, L.; Straka, T.J. 1987. Regeneration following harvest on nonindustrial private pine sites in the South: a diffusion of innovations perspective. *Southern Journal of Applied Forestry*. 11(1): 37-41.
- Galik, C.S.; Murray, B.C.; Mercer, D.E. 2013. Where is the carbon? Carbon sequestration potential from private forestland in the southern United States. *Journal of Forestry*. 111(1): 17-25.
- Han, F.X.; Plodinec, M.J.; Su, Y.; Monts, D.L.; Li, Z. 2007. Terrestrial carbon pools in southeast and south-central United States. *Climatic Change*. 84(2): 191-202.
- Hoover, C.; Stout, S. 2007. The carbon consequences of thinning techniques: stand structure makes a difference. *Journal of Forestry*. 105(5): 266-270.
- Joshi, O.; Grebner, D.L.; Munn, I.A.; Grala, R.K. 2015. Issues concerning landowner management plan adoption decisions: a recursive bivariate probit approach. *International Journal of Forestry Research*. 2015: Article ID 926303. 8 p.
- Kaminski, J. 2011. Diffusion of innovation theory. *Canadian Journal of Nursing Informatics*. 6(2): 1-6.
- Khanal, P.N.; Grebner, D.L.; Munn, I.A.; Grado, S.C.; Grala, R.K.; Henderson, J.E. 2016. Nonindustrial private forest landowner beliefs toward climate change and carbon sequestration in the southern United States. *Journal of Forestry*. 114(5): 524-531.,

- Khanal, P.N.; Grebner, D.L.; Munn, I.A.; Grado, S.C.; Grala, R.K.; Henderson, J.E. 2017a. Typology of nonindustrial private forest landowners and forestry behavior: implications for forest carbon sequestration in the southern US. *Small-scale Forestry*. 16(3): 419-434.
- Khanal, P.N.; Grebner, D.L.; Munn, I.A.; Grado, S.C.; Grala, R.K.; Henderson, J.E. 2017b. Evaluating non-industrial private forest landowner willingness to manage for forest carbon sequestration in the southern United States. *Forest Policy and Economics*. 75(2017): 112-119.
- Kline, D.; Alig, J.; Johnson, L. 2000. Fostering the production of nontimber services among forest owners with heterogeneous objectives. *Forest Science*. 46(2): 302-311.
- Korhonen, K.; Hujala, T.; Kurttila, M. 2013. Diffusion of voluntary protection among family forest owners: decision process and success factors. *Forest Policy and Economics* 26(2013): 82-90.
- Majumdar, I.; Teeter, L.; Butler, B. 2008. Characterizing family forest owners: a cluster analysis approach. *Forest Science*. 54(2): 176-184.
- Malmsheimer, R.W.; Heffernan, P.; Brink, S. [and others]. 2008. Forest management solutions for mitigating climate change in the United States. *Journal of Forestry*. 106(3): 115-171.
- Markowski-Lindsay, M.; Stevens, T.; Kittredge, D.B.; Butler, B.J.; Catanzaro, P.; and Dickinson, B.J. 2011. Barriers to Massachusetts forest landowner participation in carbon markets. *Ecological Economics*. 71(2011): 180-190.
- Measells, M.K.; Grado, S.C.; Hughes, H.G.; Dunn, M.A.; Idassi, J.; Zielinske, B. 2005. Nonindustrial private forest landowner characteristics and use of forestry services in four southern states: results from a 2002-2003 mail survey. *Southern Journal of Applied Forestry*. 29(4): 194-199.
- Murray, B.C.; Sohngen, B.; Sommer, A.J. [and others]. 2005. Greenhouse gas mitigation potential in U.S. forestry and agriculture. EPA 430-R-05-006. Washington, DC: Environmental Protection Agency, Office of Atmospheric Programs. 154 p.
- Rametsteiner, E.; Weiss, G. 2006. Innovation and innovation policy in forestry: linking innovation process with systems models. *Forest Policy and Economics*. 8(7): 691-703.
- Rogers, E.M. 2003. *Diffusion of innovations*. 5th ed. New York, NY: Free Press. 551 p.
- Soto, J.R.; Adams, D.C.; Escobedo, F.J. 2016. Landowner attitudes and willingness to accept compensation from forest carbon offsets: applications of best-worst choice modeling in Florida USA. *Forest Policy and Economics*. 63(February 2016): 35-42.
- Schubert, J.R.; Mayer, A.L. 2012. Peer influence of non-industrial private forest owners in the Western Upper Peninsula of Michigan. *Open Journal of Forestry* 2(3): 150-158.
- Thompson, D.W.; Hansen, E.N. 2012. Factors affecting the attitudes of nonindustrial private landowners regarding carbon sequestration and trading. *Journal of Forestry*. 110(3): 129-137.
- Thompson, D.W.; Hansen, E.N. 2013. Carbon storage on non-industrial private forestland: an application of the theory of planned behavior. *Small-scale Forestry*. 12(4): 631-657.
- U.S. Environmental Protection Agency. 2011. Inventory of U.S. greenhouse gas emissions and sinks: 1990-2009. EPA 430-R-11-005. Washington, DC: U.S. Environmental Protection Agency. 459 p.
- Vokoun, M.; Amacher, G.S.; Sullivan, J.; Wear, D. 2010. Examining incentives for adjacent non-industrial private forest landowners to cooperate. *Forest Policy and Economics*. 12(2): 104-110.

FINANCIAL TRADE-OFFS CONTROLLING CHINESE PRIVET (*Ligustrum sinense* Lour.) IN FORESTLANDS IN THE SOUTHERN U.S.

Fabio Jose Benez Secanho, Donald L. Grebner, Andrew W. Ezell, Robert K. Grala.¹

Abstract—Conservation of natural resources is crucial for sustainable development, and invasive species threaten native ecosystems around the world, causing biodiversity and economic losses. Chinese privet (*Ligustrum sinense*) was initially planted as an ornamental species but escaped from cultivation and became one of the most common invasive plant species in the southern United States. This study utilizes the most effective control measures found in the literature, and uses financial analysis to identify the most cost effective management regimes to eradicate this species under different area conditions. Management regimes are assessed using simulated scenarios created using six components, based on real conditions found in the southern U.S.: infestation level, field coverage, stand density, herbicide application method, herbicide, and mechanical removal of privet. Financial impact on land expectation values (LEV) is analyzed.

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